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Includes fixed-wing airplanes, helicopters, gliders, balloons, ornithopters, etc.; and specific types of complete aircraft (e.g., ground effect, airplanes, STOL, and VTOL); flight tests; operating problems (e.g., sonic boom), safety and safety devices, economics, and stability and control. For basic research see: 01 Aerodynamics. For related information see also: 31 Space Vehicles; and 32 Structural Mechanics. 3756

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Includes corrosion; physical and mechanical properties of materials (e.g., plastics); and elastomers, hydraulic fluids, etc. For basic research see: 06 Chemistry. For related information see also: 17 Materials, Metallic; 27 Propellants; and 32 Structural Mechanics. 3872

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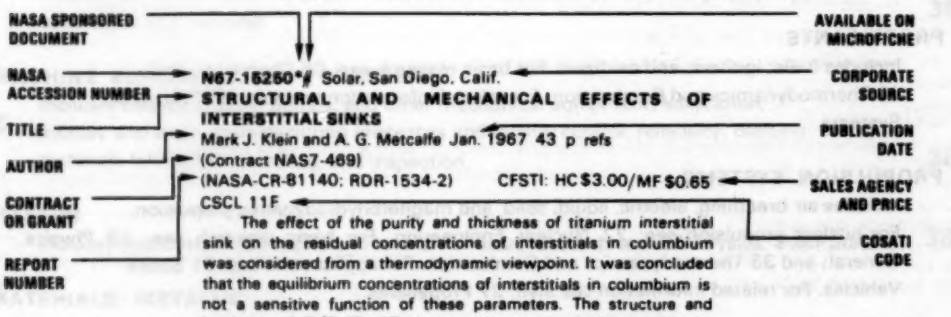
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N67-16250*# Solar, San Diego, Calif.
STRUCTURAL AND MECHANICAL EFFECTS OF INTERSTITIAL SINKS
Mark J. Klein and A. G. Metcalfe Jan. 1967 43 p refs
(Contract NAS7-469)
(NASA-CR-81140; RDR-1534-2) CFSTI: HC $3.00/MF $0.65
CSCL 11F
The effect of the purity and thickness of titanium interstitial sink on the residual concentrations of interstitials in columbium was considered from a thermodynamic viewpoint. It was concluded that the equilibrium concentrations of interstitials in columbium is not a sensitive function of these parameters. The structure and hardness of Ti/D-43 diffusion couples were correlated with the partitions of interstitials between the two metals. A reduction in the oxygen and carbon concentration in the D-43 correlates with an increase in the grain size and a change in the grain morphology of this alloy. The equilibrium partition of interstitials between the titanium and the D-43 is believed to account for an increase in the hardness of the titanium, but this partition does not seem to affect the hardness of the D-43. Author

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Scientific and Technical Aerospace Reports

A Semimonthly Publication of the National Aeronautics and Space Administration

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N67-35337*# Pratt and Whitney Aircraft, West Palm Beach, Fla. Research and Development Center.

SINGLE STAGE EXPERIMENTAL EVALUATION OF SLOTTED ROTOR AND STATOR BLADING. PART V: DATA AND PERFORMANCE FOR SLOTTED ROTOR 3–SLOTTED STATOR 2

9 Aug. 1967 120 p refs

(Contract NAS3-7603)

(NASA-CR-54548; PWA-FR-2285) CSCL 01A

An investigation of a single stage axial flow compressor, comprised of a slotted rotor and a slotted stator, was conducted as part of an overall program to evaluate the effect of slots on the performance of highly loaded compressor blade rows. The test blades were 65-series airfoils. The rotor blades had a calculated unslotted D-factor of 0.611 and an inlet relative Mach number of 0.784 near the tip. The stator blades had a calculated unslotted D-factor of 0.592 and an inlet Mach number of 0.567 near the hub. At design equivalent rotor speed and flow conditions, the slotted rotor achieved an adiabatic efficiency of 85.7% at a pressure ratio of 1.33. The stage efficiency and pressure ratio for design conditions were 79.7% and 1.30, respectively. Author

N67-35376*# Pratt and Whitney Aircraft, East Hartford, Conn.

EXPERIMENTAL EVALUATION OF TRANSONIC STATORS PRELIMINARY ANALYSIS AND DESIGN REPORT

N. T. Monsarrat and K. J. Keenan 1967 61 p refs

(Contract NAS3-7614)

(NASA-CR-54620; PWA-2749) CSCL 01A

A flow-generating rotor was designed to enable three transonic stators to be tested. The stators were designed by NASA in conjunction with the Contractor. Design analyses were conducted and the results indicate that the rotor will produce the required inlet flow to the stators. Structural and vibration analyses indicate that resonances and critical speeds occur outside the operating range and that the component stresses will be well within the capabilities of the materials used. Design details of the flow generation rotor and the three transonic stators are presented. Author

N67-35381# Aerospace Corp., El Segundo, Calif. Labs. Div.

EXPERIMENTAL RESULTS FOR MASSIVE BLOWING STUDIES, JUNE 1965–JUNE 1966

Richard A. Hartunian and Donald J. Spencer Apr. 1967 38 p refs

(Contract AF 04(695)-1001)

(TR-1001(2240-20)-13; SSD-TR-67-90; AD-654684)

Previous work on the problem of massive blowing is described. A technique for visualizing the streamline separating the blown gas from that of the oncoming stream is developed, in which a chemiluminescent reaction along the separation streamline appears as a yellow glow and is easily photographed. Data for a variety of aerodynamic shapes over a wide range of flow conditions were obtained. A major result is that the separation streamline is essentially straight for a wedge- or cone-shaped model. Pressure distributions measured on the surface of wedge and cone models indicate that the pressure decays from high values near the leading edge of blowing to low values near the trailing edge. Author (TAB)

N67-35417# Polytechnic Inst. of Brooklyn, Farmingdale, N. Y. Dept. of Aerospace Engineering and Applied Mechanics.

HYPERSONIC VISCOUS FLOW OVER SLENDER BODIES HAVING SHARP LEADING EDGES

Stanley Rudman and Stanley G. Rubin May 1967 85 p refs

(Contract AF 49(638)-1623)

(PIBAL-1018; AFOSR-67-1118; AD-655076)

The hypersonic viscous pressure interaction is treated by the development of a set of equations valid throughout the boundary layer, shock-wave structure and inviscid core. Primary interest is concerned with the nature of the leading edge continuum merged layer in which the shock wave and boundary layer are indistinguishable. Due to the parabolic nature of the equations, finite-difference solutions are attainable. The flow over a flat plate at zero incidence, as well as angle of attack, was considered. Velocity and state variable distributions across the viscous layer depict the formation of an outer shock wave and inner constant pressure boundary layer. The calculated values of surface pressure, heat transfer and shock jump conditions were at first significantly below the values predicted by strong interaction theory. Agreement was quite good downstream of the merged layer where Rankine-Hugoniot jump conditions were satisfied to within 8%. Author (TAB)

N67-35565# Douglas Aircraft Co., Inc., Long Beach, Calif. Aircraft Div.

UNSTEADY TWO-DIMENSIONAL POTENTIAL FLOW FOR TWO BODIES WITH LIFT

J. P. Giesing 15 Mar. 1967 74 p refs
(Contract Nonr-4308(00))
(DAC-33552; AD-654200)

A method for calculating the potential flow about two bodies in unsteady motion is presented. Either or both of the bodies may be lifting and in addition their shapes and flight paths may be arbitrary. The specific quantities calculated are the pressures, forces, moments and wake shapes and strengths associated with the two bodies. Numerical results are presented. Author (TAB)

N67-35609# Massachusetts Inst. of Tech., Cambridge.
A STALL FLUTTER OF HELICOPTER ROTOR BLADES: A SPECIAL CASE OF THE DYNAMIC STALL PHENOMENON
Norman D. Ham Durham, N. C., Army Res. Office, May 1967 10 p refs Presented at the Am. Helicopter Soc. 23rd Ann. Natl. Forum, Washington, D. C., May 1967
(Contract DA-31-124-ARO(D)-247)
(AROD-4846-3; AD-655003)

Several conclusions were drawn with respect to stall flutter and airload prediction of high speed and/or highly loaded helicopter rotor blades. The stall of an airfoil section during rapid transient high angle of attack changes is delayed well above the static stall angle and results in a large transient negative pressure disturbance leading to large transient lift and nose down pitching moment. The magnitude of the pitching moment is such as to generate substantial nose down pitching displacements of the blade. These pitching displacements can substantially alter the angle of attack distribution of the rotor blade. The dynamic stall phenomenon of a helicopter rotor blade can be separated into three major phases: (1) A delay in the loss of blade leading edge suction to an angle of attack far above the static stall angle, with associated airloads of the type described by classical unsteady airfoil theory. (2) A subsequent loss of leading edge suction accompanied by the formation of large negative pressure disturbance (due to the shedding of vorticity from the vicinity of the blade leading edge) which moves aft over the upper surface of the blade. Associated with this phase are high transient lift, drag, and nose-down pitching moment associated with the greatly altered pressure distribution on the airfoil. (3) Complete upper surface separation of the classic static type, characterized by low lift, high drag, and moderate nose-down pitching moment. Author (TAB)

N67-35623# Air Force Missile Development Center, Holloman AFB, N. Mex.
WALL PRESSURE MEASUREMENTS ON A ROCKET SLED SLIPPER AT M=1.7 Technical Report, 25 Mar. 1966–15 Mar. 1967
William A. Gallant Apr. 1967 44 p refs
(MDC-TR-67-68; AD-654270)

The results of an experimental study to measure aerodynamic pressures in the vicinity of and within a rocket sled slipper are presented and discussed. The main objective was to develop techniques and experimental experience in support of future work to measure wall pressures on rocket-sled slippers up to Mach 5. Four pressure orifices were installed on the rocket-sled and slipper surfaces. One of them was located two inches upstream of the slipper, another on the slipper leading edge and two inside the slipper-gap. The test conditions ranged from Mach numbers zero to 1.74. The maximum Reynolds number was 1.0 x 10 to the 7th power per foot. The measured upstream-pressure and the measured slipper leading-edge pressure behaved similar to wall pressures for flow over a surface with an upstream facing step. Maximum measured pressures upstream of the slipper and on the slipper leading edge occurred at Mach number 1.0 and were respectively 18.6 psia and 20.7 psia. The maximum measured slipper-gap pressure was 21.6 psia and occurred at the maximum Mach number of 1.74. Author (TAB)

N67-35728*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
HYPERSONIC AERODYNAMIC CHARACTERISTICS OF MINIMUM-WAVE-DRAG BODIES HAVING VARIATIONS IN CROSS-SECTIONAL SHAPE
Bernard Spencer, Jr. Washington, NASA, Sep. 1967 26 p refs
(NASA-TN-D-4079) CFSTI: $3.00 CSCL 01A

An investigation has been made at hypersonic speeds of a series of bodies having variations in cross-sectional shape and camber. The longitudinal distribution of cross-sectional area for each body conformed to the theoretical shape required to minimize the zero-lift hypersonic pressure drag of circular or elliptic bodies under the geometric contraints of given length and volume. Each body tested had constant planform area, base area, and span; the only variables were cross-sectional shape, camber, and the resultant small wetted-area changes. Cross sections tested included semicircular, elliptic, triangular, trapezoidal, and rectangular shapes. Results indicated that changing cross-sectional shape with either positive or negative camber had essentially no effect on the minimum-drag characteristics of any configuration tested. The bodies with negative camber produced favorable (positive) pitching moments and a considerable reduction in the angle of attack for maximum lift-drag ratio as compared with obtained for the bodies with positive camber. Author

N67-35730*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
AERODYNAMIC INVESTIGATION OF SOME HIGH-DRAG ENTRY SHAPES AT MACH 15.4
Frederick W. Gibson Washington, NASA, 1 Sep. 1967 27 p refs
(NASA-TN-D-4134) CFSTI: HC $3.00/MF $0.65 CSCL 01C

The effects of body shape, nose radius, and shoulder shape on separated flow, unsteady shocks, and aerodynamic drag for a series of 24 tension shell models at zero angle of attack and for a blunted 120° cone model at several angles of attack were investigated. The tests were conducted in helium flow at a Mach number of 15.4. The results showed that certain tension shell configurations merit consideration for use as unmanned planetary entry vehicles because of the high drag coefficients (1.67 maximum). Model length and nose bluntness were found to affect flow separation. The separated unsteady flow field on some tension shell models resulted in a lower drag coefficient, but the level of the pressure fluctuations was not determined. Data indicate that from high-drag considerations, an optimum shape can be found. The experimental pressure distributions indicated that the Newtonian pressure distribution is only approximate for the tension shell shape. The pressure distribution for the blunted 120° cone model was substantially the same as that predicted by Newtonian theory. The level of pressure fluctuations on the surface of this model and the static pressure and fluctuating pressure levels behind this model were of the same order of magnitude as the free-stream static pressure. Author

N67-35778*# National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.
SCALE FACTORS FOR PARACHUTE OPENING
Richard L. Barton Washington, NASA, Sep. 1967 20 p ref
(NASA-TN-D-4123) CFSTI: HC $3.00/MF $0.65 CSCL 01A

A method is derived for relating model to full-scale parachute-opening characteristics by comparing like forces in the equation of motion. Experimental results from a drop test of two scaled, ringsail parachutes are presented using the scaling method. Model laws are determined for earth simulations of planetary deployments under the restriction of matching the Mach number. Author

N67-35923 National Aerospace Lab., Tokyo (Japan).
MEASUREMENTS OF THE AERODYNAMIC DERIVATIVES OF AN OSCILLATING AIRFOIL IN SUPERSONIC FLOW AT MACH NUMBERS FROM 2 TO 3
Mitsunori Yanagizawa and Takao Ishii 1967 19 p refs In JAPANESE; ENGLISH summary
(NAL-TR-57)

The aerodynamic derivatives of a biconvex-flat airfoil (thickness ratio of 10 per cent), and double-wedge airfoils (thickness ratios of 10, 15, 20 percent), performing pitching oscillation in supersonic flow at the range of Mach number $2 \approx 3$, were measured and compared with the linearized theory, piston theory and Van Dyke's nonlinear theory which includes the effect of the airfoil thickness. The tested reduced frequency range was $0.01 \approx 0.05$ and the Reynolds number range was $2.8 \times 10^6 \approx 3.6 \times 10^6$ based on the chord length. In spite of the existence of the detached shock wave in front of the leading edge of the biconvex-flat airfoil, all experimental results agree quite well with the nonlinear theory. Schlieren photographs were taken in order to observe the flow field around the airfoils. Author

N67-36158# Aeronautical Research Council (Gt. Brit.)
A TURBULENT SKIN-FRICTION LAW FOR USE AT SUBSONIC AND TRANSONIC SPEEDS
J. F. Nash and A. G. J. MacDonald London, HMSO, 1967 16 p refs
(CP-948) HMSO: 3s 6d

A proposal is made for a skin-friction law suitable for use in two-dimensional flow at Mach numbers up to about unity. In incompressible flow the law reduces to a slightly modified form of that suggested by Nash. Compressibility effects are taken into account on the lines indicated by Spalding and Chi. Author

N67-36231 Aeronautical Research Council (Gt. Brit.).
AERODYNAMIC RESEARCH ON A FAMILY OF WINGS WITH VARIABLE SWEEP
Ph. Poisson-Quinton and M. Enselme 13 Mar. 1967 53 p refs
(ONERA-TP-272/1965; ARC-28907)

Research was undertaken on a family of variable-sweep wings to determine the influence of the pivot position on the aerodynamic characteristics during the rotation of the wing. The problem was first treated as one of incompressible flow, both by the lifting surface method in the electric tank and by wind tunnel testing of schematic models; the general laws were then deduced for the development of the lift curve slope and of the centre of pressure as a function of sweep for the various locations of the pivot. In addition, dynamic testing of a particular configuration showed the variation of damping in pitch and in roll during the pivoting of the wing. The possibilities of high lift being achieved on the wing at low speeds are limited by the premature separation of the boundary layer at the leading edge; in order to postpone the onset of stalling, a cambered edge is proposed of which the conical generation is calculated for a highly swept wing to ensure its adaptability for high speeds; experiment has shown that this camber greatly improved the aerodynamic characteristics of the aircraft. Author

N67-36280*# Boeing Co., Renton, Wash. Commercial Airplane Div.
A MODIFIED LINEAR THEORY AND ITS APPLICATION TO WINGS WITH SUPERSONIC EDGES
F. A. Woodward and E. La Rowe Aug. 1967 300 p refs
(Contract NAS2-3179)
(NASA-CR-73108; D6-15045) CSCL 01A

An approximate solution to the nonlinear potential equation for supersonic flow $(M^2(x, y, z) - 1)\,\phi_{xx} + \phi_{yy} + \phi_{zz} =$ 0 is obtained by assuming the local Mach number constant and equal to that given by linear theory on each of a large number of geometric panels located on the wing surface. First-order Mach lines on the wing, which are obtained by numerical integration, establish new influence regions for the panels. The local velocity components are then calculated which satisfy second-order boundary conditions at panel control points. Finally, the pressure coefficients, forces, and moment acting on the wing are determined. The theoretical results are compared with linear theory, shock-expansion theory, and experiment for two-dimensional wedges and supersonic leading edge delta wings. The modified theory gives improved estimates of the surface pressure coefficient over those given by linear theory, and agrees closely with shock-expansion theory over a wide range of Mach numbers. The correlation of theory with experiment is not quite as satisfactory. A description and listing of the computer program, together with instructions for its use, are included in the report. Author

N67-36410# Air Force Systems Command, Wright-Patterson AFB, Ohio.
THE APPLICATION OF A NONSIMILAR LAMINAR BOUNDARY LAYER ANALYSIS TO HYPERSONIC INLET COMPRESSION SURFACES
Dennis Sedlock Dec. 1966 37 p refs
(AFFDL-TR-66-146; AD-654672)

The report presents the results of an investigation in which the Smith and Clutter nonsimilar laminar boundary layer analysis is compared to experimental data and a modified linearized similar solution on typical hypersonic two-dimensional and axisymmetric inlet compression surfaces. The representative cases presented have a Mach number range of 11.6 to 16.87 and a unit Reynolds number of 60,000 to 400,000. For these conditions on the models investigated, the nonsimilar solution was found to treat transverse curvature as a first rather than a second order effect. Such factors as the input nondimensional boundary layer thickness, the distance between stations along the surface, and the selection of reference conditions were found to have an effect on the accuracy of the solution. The method showed satisfactory agreement with experimental data and the modified similar solution. Although not prohibitively long, the length of computer time suggests that the program should be used as a final design analysis tool rather than being applied in preliminary design stages. The detailed output of various quantities in the viscous layer makes the program particularly useful where temperature and velocity profiles are required. Author (TAB)

N67-36431# Aeronautical Research Council (Gt. Brit.)
FREE-FLIGHT TESTS IN THE NPL 6-in. (15-CM) SHOCK TUNNEL OF MODEL HB-2 USING MULTIPLE SPARK RECORDING
L. Pennelegion, R. F. Cash, and M. J. Shilling London, HMSO, 1967 23 p refs
(CP-934) HMSO: 6s

Free-flight measurements of axial force, normal force and pitching moment of an HB-2 model have been made in the NPL 6-in. (15-cm) shock tunnel and the results compared with force balance data obtained elsewhere. The displacement of the polyurethane models was recorded as a set of overlapping images on one photographic plate. Author

N67-36567* Scientific Translation Service, La Canada, Calif.
INVESTIGATION OF DRAG AND HEAT TRANSFER DURING AIR MOTION IN DIVERGENT AND CONVERGENT NOZZLES [ISSLEDOVANIYE SOPROTIVLENIYA I TEPLOOBMENA PRI DVIZHENII VOZDUKHA V DIFFUZORAKH I KONFUZORAKH]

P. N. Romanenko, A. I. Leont'yev, and A. N. Oblivin Washington, NASA, Aug. 1967 16 p refs Transl. into ENGLISH from Teploi Massoperenos. III Obshchiye Vopr. Teploobmena (Moscow), 1963 p 349–360
(Contract NASw-1498)
(NASA-TT-F-11221) CSCL 01A

Drag and heat transfer of turbulent airflow was investigated in axisymmetric divergent and convergent nozzles at temperatures of 425 to 623°K in the flow and 286 to 320°K in the water-cooled channel walls. The existing methods of calculating boundary layers (Buri, Gruschwitz, Kalikhman, Nikuradze) are found to yield considerable error in the conditions studied. A method of calculating axisymmetric boundary layers in turbulent airflows with a pressure gradient under conditions of heat transfer is proposed. Author

N67-35308# Gt. Brit. Ministry of Aviation, London. Aeronautical Research Council.
TESTS ON A SIMULATED LIFTING FAN SYSTEM WITH INLET CROSS FLOW
R. C. Turner and D. W. Sparkes HMSO, 1967 35 p refs Supersedes NGTE-M-385; ARC-26711; See X65-13314
(ARC-R&M-3461; NGTE-M-385; ARC-26711) HMSO: 14s

A single-stage fan was fitted with three simple annular intakes in turn, and tested with inlet cross flow in order to simulate the conditions imposed on an aircraft lifting installation during the transition period. The major difference between the intakes was the value of the edge radius which was 0.07, 0.15 and 0.25 times the fan tip radius respectively. The overall performance dropped as the cross flow was increased, but the intake with the largest edge radius was by far the least sensitive in this respect. The drop in overall performance could be attributed to two factors; the pressure losses in the intake and the effect of maldistribution of the flow on the blading performance. With the worst intake, the effect of the pressure losses was greater than that of the maldistribution, while with the best, the maldistribution effect predominated, although it was itself small. In general, the tests pointed to the desirability of developing the intake as a separate component to give the lowest attainable pressure loss. Author

02 AIRCRAFT

Includes fixed-wing airplanes, helicopters, gliders, balloons, ornithopters, etc; and specific types of complete aircraft (e.g., ground effect machines, STOL and VTOL); flight tests; operating problems (e.g., sonic boom); safety and safety devices; economics; and stability and control. For basic research see: 01 Aerodynamics. For related information see also: 31 Space Vehicles; and 32 Structural Mechanics.

N67-35318# Mechanics Research, Inc., El Segundo, Calif.
CRASH LOADS ENVIRONMENT STUDY
Donald P. Fitzgibbon and Reuben P. Vollmer Feb. 1967 179 p refs
(Contract FA-66-WA-1511)
(DA-67-2)

Survivable crash environments for commercial aircraft are analyzed based on crash test data on both full-scale aircraft and aircraft components, and on actual commercial aircraft crashes during the 1955–1965 period. Crash test severity was determined by relating the characteristics of the measured acceleration time histories to the characteristics of human tolerance to acceleration. It was shown that the tolerable acceleration magnitudes increase as the duration of the pulse decreases. In assessing commercial crash data, it was found that the most common survivable accident can be described as occurring during the landing phase, with null pitch, roll and yaw angles, an impact angle of less than 5°, and an impact velocity of 166 feet per second. Severity is considered highly dependent upon the configuration, structural design, and weight. For components attached to the fuselage, the crash environment can be generalized through the use of shock spectra to produce design and test criteria. For fuel cells integral to the wing, the criteria can be developed from the sine wave accelerations which produce the same velocity change as the measured acceleration. M.G.J.

N67-35323# Mississippi State Univ., State College. Dept. of Aerophysics.
XV-11A: DESCRIPTION AND PRELIMINARY FLIGHT TEST
Sean C. Roberts, Aberdeen W. Stewart, Virgil L. Boaz, Glenn D. Bryant, Lawrence J. Mertaugh et al May 1967 106 p refs /ts Aerophys. Res. Rept. No. 75
(Contract DA-44-177-AMC-266(T))
(USAAVLABS-TR-67-21; AD-654469)

The XV-11A is a polyester reinforced fiber glass STOL aircraft. This four-place aircraft, powered by a 250-horsepower T-63 turbine engine, was designed to achieve high-lift coefficients by means of a variable camber wing with distributed suction boundary layer control. A shrouded propeller was used for thrust augmentation at low forward velocities, and beta control on the propeller was successfully used as a drag increment for glide path control. To date, the XV-11A aircraft has flown 49 flights with a total flight time of 35 hours. The majority of the flight time was involved in aerodynamic research of the shrouded propeller, the distributed suction boundary layer control system and in an evaluation of the general handling characteristics of the aircraft. A minimum of performance data was collected since the primary objective was aerodynamic research. The fiber glass material demonstrated the excellent possibilities of this type of construction when complex, aerodynamically smooth curvatures are desired. Author (TAB)

N67-35325# Dunlap and Associates, Inc., Santa Monica, Calif. Western Div.
MEASURES OF CARRIER LANDING PERFORMANCE UNDER COMBAT CONDITIONS
Clyde A. Brictson, Peter F. Hagen, and Joseph W. Wulfeck Jun. 1967 119 p refs
(Contract Nonr-4984(00))
(AD-654563) CFSTI: HC $3.00/MF $0.65

Empirical measures of day and night carrier landing performance for five types of jet aircraft under combat conditions are described and compared. Successful approaches (safe landings) and unsuccessful approaches (bolters, wave offs) are analyzed and the results are discussed in terms of operational implications. Landing performance criteria are developed from the empirical measures to provide a rationale for the design and evaluation of visual landing aids. Author (TAB)

N67-35361# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.
AIRCRAFT TRACTOR ROCKET-ESCAPE SYSTEM-SIX-DEGREE-OF-FREEDOM DIGITAL SIMULATION Final Report
Frank Bader and Dean R. Coleman Feb. 1967 69 p refs
(Contract NOw-62-0604-c)
(TG-864; AD-654446)

The report presents a six-degree-of-freedom digital simulation of an aircraft tractor rocket air crew escape system. The simulation described is a six-degree-of-freedom simulation in that each of the objects considered is free to translate linearly in three directions and rotate about these three linear axes. The simulation considers

the motions of the four objects comprising the escape system: the airplane, the tractor rocket, the towline, and the crewman. The simulation begins at the instant the tractor rocket has been ejected from its catapult and terminates when the tractor rocket has burned out. Author (TAB)

N67-35617# National Research Council of Canada, Ottawa (Ontario).
A NEW ASPECT OF MAN'S RELATIONS WITH BIRDS
H. F. Lewis 23 Nov. 1966 6 p
(CM4-S.17-2) CFSTI: HC $3.00/MF $0.65

Bird hazards to aircraft, especially to jet engines, and ways of reducing them are discussed. It is pointed out that the best ways of discouraging birds from airport areas is to eliminate the attractions such as food (earthworms, insects, grain, berries, garbage, and ponds) and shelter in the buildings. Another suggested means of reducing the hazard is the use of radar for tracking bird migrations, to keep the pilot informed much as he is informed about weather conditions. N.E.N.

N67-35721*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
SUPERSONIC TRANSPORT AIRPORT AND COMMUNITY JET NOISE DURING TAKEOFF AND INITIAL CLIMB
John B. Whitlow, Jr., Robert W. Koenig, and Gerald A. Kraft Washington, NASA, Sep. 1967 22 p refs
(NASA-TM-X-1452) CFSTI: HC $3.00/MF $0.65 CSCL 01C

An analytical study was made to illustrate the manner in which engine design, sizing, and operation affect the airport and community jet-noise environment of a representative fixed-wing supersonic commercial transport. Both afterburning turbojet and duct-burning turbofan engines were considered. Neither engine type was assumed to have noise suppressors. The numerical results pertain only to the selected airplane characteristics and method of computing engine noise. Nevertheless, the data show how the selection of noise constraints can lead to the need for larger engines than those corresponding to maximum payload capacity. Furthermore, the necessary engine sizes can exceed those required to meet other operational constraints, such as takeoff distance or engine-out climb ability. Author

N67-35733*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
A SUMMARY OF OPERATIONAL EXPERIENCES OF THREE LIGHT OBSERVATION HELICOPTERS AND TWO LARGE LOAD-LIFTING MILITARY HELICOPTERS
Daniel J. DiCarlo Washington, NASA, Sep. 1967 36 p refs
(NASA-TN-D-4120) CFSTI: HC $3.00/MF $0.65 CSCL 01C

A survey of the operations of three different prototype light observation helicopters and of two large load-lifting helicopters, each involved in simulated military operations, was conducted with helicopter flight recorders in order to provide a basis for extending helicopter design and service life criteria. The operating experiences are presented in terms of the time spent within different airspeed brackets, the classifiable flight conditions of climb, en route, and descent, and at different rotor rotational speeds. Normal acceleration occurrences above the incremental value of ±0.4g are also presented. Results for this survey show that each helicopter spent a large amount of time in the upper portion of the speed range and exceeded its handbook maximum velocity for a small percentage of the total flight time. Broad variations in rates of climb and descent occurred over a wide range of airspeeds. Normal acceleration experiences reached 75 to 98 percent of the aerodynamically attainable maximum estimated for the specific flight conditions. Rotor rotational speeds were held at the normal values for most of the flight time, but a large number of values exceeded either the upper or lower red-line limits. Author

N67-35757 Civil Aeronautics Board, Washington, D. C. Bureau of Safety.
GENERAL AVIATION ACCIDENTS: A STATISTICAL REVIEW, CALENDAR YEAR 1964
Feb. 1967 106 p
(BOSR-7-5)

Tables are presented of detailed information on civil aircraft accidents. The tables cover all categories of aircraft, small fixed-wing aircraft, large fixed-wing aircraft, rotorcraft, and the yearly accident record. Data presented include personal injury, type of aircraft, kind of flying and phase of operation, and cause and related factors. N.E.N.

N67-35930*# Scientific Translation Service, La Canada, Calif.
MILITARY ROCKETS IN THE 19th CENTURY [COHETES DE GUERRA EN EL SIGLO XIX]
Juan Barrios Gutiérrez Washington, NASA, Jul. 1967 34 p Transl. into ENGLISH from Rev. Hist. Mil. (Spain), v. 7, no. 14, 1963 p 139–173
(Contract NASw-1496)
(NASA-TT-F-11128) CSCL 19G

This article discusses the possible origin and first uses of rockets. The assumption that Greek fire was a forerunner of rockets is discussed and analyzed. A historical summary of the development of rockets is given, including the history of rockets in Spain. Author

N67-35959 College of Aeronautics, Cranfield (England). Dept. of Flight.
FREQUENCY RESPONSE OF AN AIRCRAFT AS DETERMINED FROM TRANSIENT FLIGHT TESTS USING THE FOURIER TRANSFORMATION METHOD OF ANALYSIS
D. W. Laurie-Lean May 1967 54 p refs
(Contract PD/28/028)
(COA-AERO-175)

The longitudinal dynamic response characteristics of a twin-engined propeller-driven aircraft determined from flight measurements are presented and compared with predictions based on theoretical studies. Transient responses to pilot-applied pulsed motions of the elevator control surfaces were recorded. The transient data was then converted into frequency response form by means of the Fourier transformation and compared with predicted responses calculated from the basic equations of motion of the aircraft. Detailed experience of the determination of frequency responses with regard to data sampling frequency and control input shape, using the Fourier transformation method, was obtained. Experimentally-determined transfer functions were used for the evaluation of the stability derivatives that have the greatest effect on the dynamic response of the aircraft. Some experience was also obtained with automatic data recording and processing equipment using magnetic tape, but no satisfactory frequency responses were obtained using this method. Author

N67-36005# Sandia Corp., Albuquerque, N. Mex.
DESIGN AND DEVELOPMENT OF A THREE-STAGE PARACHUTE SYSTEM FOR LOW-LEVEL DEPLOYMENT UP TO MACH 1.2
William B. Pepper May 1967 42 p refs
(Contract AT(29-1)-789)
(SC-DR-66-2707) CFSTI: HC $3.00/MF $0.65

The design and development of a parachute system suitable for low-level release and high-velocity deployment are presented. Rocket-boosted field tests of the system along with theoretical trajectory studies indicate that the retardation system can successfully recover a 1300-pound test vehicle released from an aircraft flying at Mach 1.2 and 150 feet above the terrain. Author (NSA)

N67-36044# School of Aerospace Medicine, Brooks AFB, Tex. Aerospace Medical Div.
CABIN PRESSURIZATION CHARACTERISTICS OF USAF AND COMMERCIAL TRANSPORT AIRCRAFT
Alan J. Greenwald and Robert G. Mc Iver May 1967 22 p refs /ts Rev.-2-67
(AD-654311)

A reference list containing cabin pressurization characteristics of USAF aircraft and of several commercial transport aircraft has been compiled. It is anticipated that this list will be of value to physicians confronted with the necessity of transporting patients by air. Personnel engaged in research and development related to problems of cabin pressurization and pressure suits should also find such a list of value. A review of some medical conditions adversely affected by reductions in the barometric pressure and partial pressure of oxygen is included, with special emphasis being given to decompression sickness. Author (TAB)

N67-36069 National Research Council of Canada, Ottawa (Ontario).
BIRD HAZARDS TO AIRCRAFT OPERATION BIRDTRACK 66/1
[1966] 46 p

The radar, photographic, and meteorological procedures developed to forecast the intensity of bird migration are discussed, in relation to their effectiveness in avoiding or reducing the risk of in-flight bird strikes. The feasibility of forecasting the movement of hazardous bird concentrations on the basis of meteorological and ornithological information was examined, with the validity of the forecasts issued proven by 16mm photo/radar recording, or by time-delay Polaroid photography. During the spring 1966 migratory period, a forecast accuracy of about 83% was attained, with about a 70% accuracy for the fall migration period. It is pointed out, however, that although forecasting was successful during normal intensities, these high percentages were not achieved when a new migration wave front moved into the area. The possibility of setting up a synoptic network of bird tracking stations is mentioned. M.G.J.

N67-36117 Nationaal Lucht-en Ruimtevaartlaboratorium, Amsterdam (Netherlands).
SELECTIVE BIBLIOGRAPHY ON AIR CUSHION VEHICLES
A. Harting 27 Feb. 1967 115 p refs

The bibliographic listing is classified according to data on annular jets, labyrinth seals, diffusers, plenum chambers, levapad air bearings, ram wings, navigation control, structures and materials, and propulsion. Related reports, which may be of interest are included. Author

N67-36142* National Aeronautics and Space Administration, Washington, D. C.
WIND-TUNNEL TESTS ON THE GROUND EFFECT [ETUDE EN SOUFFLERIE DE L'EFFET DE SOL]
A. de Sievers Jul. 1967 56 p refs Transl. into ENGLISH from the French Tech. Note No. 87, 1965
(NASA-TT-F-11059; TN-87) CSCL 01B

Attempts at predicting the ground effect, for aircraft of low aspect ratio on takeoff or landing, by theoretical methods are reviewed, followed by a description of experimental methods and wind-tunnel tests on slender wings made at the ONERA, using the methods of conformal wing mapping and simulation of the ground by a fixed floor. Despite imperfections in the method, due to the development of a boundary layer on the floor, the approximation obtained is satisfactory for sufficiently slender (wing or aircraft) models. Experiments are described that permit determining the coefficients of two empirical corrections for lift and drag, in the presence of ground effect, based on the experimental polar without ground effect. Author

N67-36154# Ministry of Technology, London (England). Aeronautical Research Council.
THE APPLICATION OF NON-DIMENSIONAL METHODS TO THE PLANNING OF HELICOPTER PERFORMANCE FLIGHT TRIALS AND THE ANALYSIS OF RESULTS
P. A. Knowles HMSO, 1967 60 p refs Supersedes AAEE/TECH/322/PERF; ARC-28091; See X66-19159
(ARC-CP-927; AAEE/TECH/322/PERF; ARC-28091) CFSTI: HC $3.00/MF $0.65

The advantages of using nondimensional methods in helicopter performance trials are outlined and the nondimensional groups of parameters used to define level flight, partial climb, vertical climb, autorotation, and hovering are stated. Each of these flight modes is examined in turn and the methods of planning trials, preparing flight data and analysing results are discussed. Some examples of trial planning are included. Author

N67-36403*# Boeing Co., Renton, Wash. Commercial Airplane Div.
A NEAR-FIELD APPROACH TO THE SONIC BOOM PROBLEM
F. A. Woodward Aug. 1967 34 p refs
(Contract NAS2-3719)
(NASA-CR-73109; D6-15046) CFSTI: HC $3.00/MF $0.65 CSCL 01B

Results are presented on the feasibility of extending an existing supersonic wing body analysis and design method to the problem of calculating the pressure signature and associated shock wave pattern in the field surrounding arbitrary airplane configurations at supersonic speed. The conclusion reached is that theoretical methods are presently available to make this extension possible. The steps involved are outlined in some detail. The principal difference between the above method and the currently accepted theory of Whitham is shown to be in the singularity representations used. The wing body method represents the configuration by a spatial distribution of singularities over the entire wing and body surfaces, while Whitham's method uses an equivalent linear distribution of singularities along the body axis. In the far field, both methods give the same results; but in the near field, the spatial singularity representation is expected to be superior. An improved understanding of the wave pattern in the near field could lead to new techniques for modifying or reducing the pressure signature in the far field. Author

N67-36563*# Honeywell, Inc., Minneapolis, Minn.
STUDY OF FLUID FLIGHT PATH CONTROL SYSTEM
Washington, NASA, Aug. 1967 229 p
(Contract NAS4-763)
(NASA-CR-758; Rept.-20175-FR1) CFSTI: HC $3.00 CSCL 01D

Advanced concepts for lateral and pitch flight path stabilization of light aircraft were studied. A major consideration was the suitability of the concept configuration of pure-fluid mechanization. The concept configurations were evaluated on an analog simulation of the Cessna 310 airplane. Ramp and step wind inputs were used as disturbances in the evaluation. The results of the study are tabulated and compared with certain pilot acceptance and ease of mechanization criteria. Author

N67-36593# Northrop Corp., Hawthorne, Calif. Norair Div.
AIRCRAFT PRELIMINARY DESIGN REPORT V/STOL JET OPERATIONS RESEARCH AIRPLANE DESIGN STUDY VOLUME I: AIRPLANE SPECIFICATION FOR NORTHROP N-309 NASA V/STOL JET OPERATIONS RESEARCH AIRPLANE
Jul. 1967 162 p
(Contract NAS1-6777)
(NASA-CR-88083; NOR-67-8; Vol. I) CSCL 01C

Preliminary design and airplane requirements are described for a modified N-309, NASA V/STOL jet operations research vehicle. Attention is given to the specifications for aerodynamics, structural design criteria, wing and tail groups, the body, alighting gear and flight control systems, the engine sections, propulsion and secondary power systems, mission and traffic control subsystems, armament, and ground handling and servicing provisions. The specification for the stability augmentation and variable stability systems and their ground support hardware is detailed, and interchangeable and replaceable components are listed. A listing of government furnished aircraft equipment that is contractor installed is also appended. M.W.R.

N67-36600 National Research Council of Canada, Ottawa (Ontario).
BIRD STRIKES
M. S. Kuhring Jul. 1966 8 p ref Presented at No. 1 Air Div. RCAF, Metz, France, 18–19 Jul. 1966
(CM4-S.17-2)

While it appears to be difficult to protect existing aircraft from damage due to bird strikes, the position is taken that improvements and modifications can be made to alleviate some of the dangers involved. Operational use of radar and synoptic weather forecasts to predict bird movements may prove useful for low flying as well as high flying aircraft. Aircraft speed is discussed; and attention is given to aircraft components such as wings, stabilizers, fins, grids or guards for engine intakes, air intakes, compressor blade protection, windshields, and radomes. M.W.R.

03 AUXILIARY SYSTEMS

Includes fuel cells, energy conversion cells, and solar cells; auxiliary gas turbines; hydraulic, pneumatic and electrical systems; actuators; and inverters. For related information see also: 09 Electronic Equipment; 22 Nuclear Engineering; and 28 Propulsion Systems.

N67-35310*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
ELECTRICAL HEATER FOR LIQUID METALS AT ELEVATED TEMPERATURES
L. Hays, D. O'Connor, and G. Haskins 15 Aug. 1967 24 p refs
(NASA-CR-87994; JPL-TR-32-1146) CFSTI: HC $3.00/MF $0.65 CSCL 13A

Design relations for high temperature electrical heaters of the conduction type for liquid metals are summarized in this report. The results of 500 hours testing of this type of heater in 2000°F lithium are given. The electrical resistivity and breakdown strength of swaged beryllia and alumina were measured to 2200°F and these data are also presented. Design of a prototype heater for a 100-kWt cesium–lithium erosion loop is discussed, together with preliminary calculations for the heater for a 300-kWe liquid metal magnetohydrodynamic conversion system. Author

N67-35394*# Boeing Co., Seattle, Wash. Aerospace Group.
LARGE AREA SOLAR ARRAY Quarterly Report, Mar. 20-Jun. 19, 1967
J. W. Ketchun, F. W. McAfee, J. L. Apperson, and Weikel Jul. 1967 252 p refs
(Contracts NAS7-100; JPL-951653)
(NASA-CR-87989; D2-113355-3; QR-3) CSCL 10A

Structural, mechanical, and electrical design data are detailed for the large area solar array (LASA) which is being developed to provide a power source for electrical propulsion and onboard spacecraft power for an unmanned Mars flyby probe. Efforts were concentrated on the tie-down system and its release mechanism for the stowed panel assembly, and on detail definitions of the boost tie-down and shear tie-joint systems. The basic configuration of the deployment demonstration equipment was established, and deployment test requirements and instrumentation were selected. Major ground support equipment (GSE) preliminary design problems were resolved in relation to the deployment, transportation, and handling equipment, electrical instrumentation, and environmental test equipment. Interfaces between GSE, the array, and facilities were determined. Performance analyses data are presented, and the findings indicate that the LASA design will meet the criteria for stiffness, strength, weight, power output, quality, and reliability. M.G.J.

N67-35445*# Pratt and Whitney Aircraft, East Hartford, Conn.
RESEARCH AND DEVELOPMENT OF HIGH-PERFORMANCE AXIAL-FLOW TURBOMACHINERY. VOLUME I: DESIGN OF TURBINE COMPRESSOR
P. Bolan, R. Cohen, and W. K. Gilroy Jun. 1967 160 p
(Contract NAS3-4179)
(NASA-CR-800; PWA-2977, Vol. I) CFSTI: HC $3.00/MF $0.65 CSCL 10A

Pratt & Whitney Aircraft has conducted the design of an axial-flow turbine-compressor as candidate turbomachinery for a Brayton-cycle space power-plant. The overall design of the turbine-compressor is discussed and the results of gas bearing test programs are presented. Tests of the rotor support system using a rotor dynamics simulator have demonstrated satisfactory gas bearing operation at the design speed of 50,000 rpm and at 120 per cent of design speed. During this testing the gas bearing cooling provisions also demonstrated satisfactory performance. Tests were conducted on air and argon at ambient pressure levels of 14.7 and 7 psia, in both horizontal and vertical orientations with mass unbalance introduced in the rotor to simulate end-of-life conditions. Thrust loads above expected levels were tested on the hydrodynamic thrust bearing and loads up to 100 pounds were tested on the hydrostatic thrust bearing to simulate maximum anticipated startup conditions. Bearing temperatures up to 310°F were demonstrated as well as hydrodynamic startup on the journal bearings. Author

N67-35452# California Univ., Livermore. Lawrence Radiation Lab.
OUTPUT POWER CHARACTERISTICS OF THERMIONIC CONVERTER ARRAYS UNDER PARTIAL FAILURE CONDITIONS
James R. Long 24 Apr. 1967 31 p refs Presented at the 2d Intersoc. Energy Conversion Eng. Conf., Miami Beach, Fla., 13–17 Aug. 1967
(Contract W-7405-ENG-48)
(UCRL-70282; CONF-670806-1) CFSTI: HC $3.00/MF $0.65

The output characteristics of thermionic converter arrays are determined as a function of interconnection scheme, interconnection resistance, converter failure modes and patterns, and converter characteristics. The arrays consisted of series strings of converters paralleled with each other by resistive interconnections. The use of additional interconnections is considered to form three-dimensional arrays in which edge effects inherent in planar arrays are eliminated. From an analytical point of view, the applicability of a strictly linear model for the converter is improved with three-dimensional arrays. The output of a three-dimensional array under failure conditions is not significantly greater than that of a planar array, and array shape does not have a strong influence on power output. The array reliability is shown to be greater than the converter reliability. A study of the effect of introducing a

statistical distribution of converter parameters appears to show less power loss under failure conditions. A study of the effect of matching the load impedance of a failed array shows that the impedance change is small. Author (NSA)

N67-35470 Joint Publications Research Service, Washington, D. C.
RESEARCH IN SOLAR ENGINEERING
24 May 1967 53 p refs Transl. into ENGLISH from Geliotekhnika (Tashkent), no. 6, 1966
(JPRS-41144; TT-67-31785) CFSTI: $3.00

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4. POWER PARAMETERS OF THE SOLAR CONCENTRATOR OF THE SV-1 WATERLIFT UNIT D. I. Teplyakov, R. R. Aparisi, Ya. G. Kolob, R. A. Zakhidov, and A. Annayev p 22–28 refs (See N67-35474 21-33)

5. THERMOELECTRIC PARAMETER MEASUREMENT TECHNIQUE Ya. Agayev and A. R. Mikhaylov p 29–37 refs (See N67-35475 21-33)

6. MANUFACTURING OF PARABOLOID AREA COLLECTORS BY ROTATION G. Ya. Umarov, A. K. Alimov, F. N. Suleymanova, and D. N. Alauutdinov p 38–41 refs (See N67-35476 21-15)

N67-35471 Joint Publications Research Service, Washington, D. C.
INTEGRAL SHORT-CIRCUIT CURRENT OF SOLAR CELLS FROM THEIR SPECTRAL CHARACTERISTICS
M. M. Koltun, T. M. Golcuner, and M. N. Kholeva *In its* Res. in Solar Eng. 24 May 1967 p 1–7 refs (See N67-35470 21-03)

A technique by which the absolute spectral sensitivity of a photocell is converted to the power spectral distribution of the light source radiation with subsequent integration of the resulting spectral distribution curves is described. The integral short circuit current of the photocell can then be determined for operation with any light source with high accuracy. The technique was used to determine the optimal parameters of two layer coatings for silicon photocells, and to solve the problem of protection and temperature stabilization of the cells under conditions of airless space. The technique was also used to design coatings for the photocells of other systems, in particular those based on gallium arsenide. L.S.

N67-35472 Joint Publications Research Service, Washington, D. C.
PRELIMINARY RESULTS OF EXPERIMENTAL TESTS OF THERMOEMISSIVE SOLAR CONVERTERS
V. A. Korobov, O. A. Nevezhin, and Ye. M. Yurin *In its* Res. in Solar Eng. 24 May 1967 p 8–13 (See N67-35470 21-03)

Preliminary experimental investigation results are presented for metal–ceramic thermoemissive converters intended for converting the radiant energy of the sun. Description of the design is also given. Author

N67-35473 Joint Publications Research Service, Washington, D. C.
COMPARATIVE CHARACTERISTICS OF SOLAR FURNACE POWER REGULATORS
A. V. Vartanyan *In its* Res. in Solar Eng. 24 May 1967 p 14–21 refs (See N67-35470 21-03)

Comparative characteristics of power regulators of solar furnaces and the techniques of qualitative analysis of separate systems are investigated. The dependence data allow the choice of the regulator type according to concrete investigations on solar furnaces. Author

N67-35534*# Westinghouse Electric Corp., Pittsburgh, Pa. Research Labs.
SEPARATOR DEVELOPMENT FOR A HEAT STERILIZABLE BATTERY Quarterly Report, Jan. 1–Mar. 31, 1967
A. Langer, R. G. Charles, and C. R. Ruffing 31 Mar. 1967 82 p Prepared for JPL
(Contracts NAS7-100; JPL-951525)
(NASA-CR-88014; Rept.-67-986-BSEPA-R1; QR-3) CFSTI: HC $3.00/MF $0.65 CSCL 10C

Pressure effects on films used for experimental inorganic filled composite separators for a heat sterilizable silver zinc battery were investigated. Other factors influencing film resistance, and the control of solvent extraction by solvent water mixtures, are discussed. The continuous coating of films on Webril support; membrane sterilization tests; and characterization tests for the membranes are described. The most satisfactory separator thus far appears to be a polypropylene reinforced, water extracted, compressed film of polysulfone with hydrated zirconium oxide or titanium oxide filler material at a loading of about 30 g filler per 15 g polysulfone. L.S.

N67-35539# American Cyanamid Co., Stamford, Conn. Research Labs.
HYDROCARBON FUEL CELL ELECTRODES Progress Report, Jul. 16, 1966–Jan. 15, 1967
V. Corso, Jr. and J. Di Palma Mar. 1967 45 p refs
(Contract DA-44-009-AMC-897(T))
(PR-4; AD-654442) CFSTI: HC $3.00/MF $0.65

The Interim Progress Report Number 4 is of a research program on fuel cell electrodes conducted by the Central Research Division of American Cyanamid Company under contract with the U. S. Army Engineer Research and Development Laboratories. The scope of the contract has been broadened to include work in the sulfuric acid as well as phosphoric acid system. Primary emphasis has shifted from work with n-octane fuel to work with impure hydrogen. The principal objective in the phosphoric acid system is to obtain 0.75 volts at current densities in excess of 100 amperes per square foot, using minimum electrocatalyst loading, in cells operating at temperatures of 100-150 C, with hydrogen containing 3-5 mole % carbon monoxide. Work in the sulfuric acid system is proceeding along similar lines but at lower cell temperatures (65-100 C) and lower carbon monoxide concentrations. Author (TAB)

N67-35553*# Thermo Electron Engineering Corp., Waltham, Mass.
SOLAR THERMIONIC GENERATOR DEVELOPMENT Quarterly Report, Mar. 1–Jun. 7, 1967
Jun. 1967 41 p refs Prepared for JPL
(Contracts NAS7-100; JPL-951263)
(NASA-CR-88013; TE-4055-123-67; QR-6) CFSTI: HC $3.00/MF $0.65 CSCL 10B

Converter T-206 was fabricated and tested. The converter has particularly flat electrodes and is a good specimen of the

T-200 series. The test data revealed a higher output due to the use of a rhenium collector. Output characteristics were found to be sensitive to the type of electron-bombardment filament which is used in the converter heat source. For this reason, the results presented in this report are of a preliminary nature. The data from converter T-206 was sufficiently accurate to allow evaluation of collector heat transfer. The collector temperatures obtained at selected values of converter output current were compared with those predicted by a second collector-radiator model. It was found that the actual collector heat transfer exceeds the predicted values by a constant amount. Author

N67-35615*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio
CONDITIONING AND STEADY-STATE PERFORMANCE OF SNAP-8 TUBE-IN-SHELL MERCURY BOILER
James A. Albers, William T. Wintucky, and Sol H. Gorland Washington, NASA, Sep. 1967 47 p refs
(NASA-TM-X-1441) CFSTI: HC$3.00/MF$0.65 CSCL 18N

The tube-in-shell boiler was a cross-counterflow heat exchanger consisting of four 1-inch tubes coiled inside a concentric cylindrical annulus. An analysis of the boiler performance is presented for a total operating time of 1087 hours. The boiler-outlet heat-transfer parameters increased with time to approximately 300 hours of boiler operation and did not appreciably change thereafter. For boiler operation after 300 hours, the average outlet quality was 93 percent with an average superheat of 300°F. Average outlet absolute enthalpy was 153 Btu per pound, which is 5 percent less than design. Although the boiler mercury-vapor outlet quality and terminal temperature difference remained essentially constant after 300 hours of operation, the boiler internal heat transfer continued to improve. Performance curves of the boiler indicated that the chosen design NaK- to mercury-flow-rate ratio was above its optimum value. About 700 hours of operation, the overall pressure drop ranged from 78 to 103 pounds per square inch, which corresponds to mercury-flow rates of 6350 to 9350 pounds per hour. The NaK side boiler pressure drop ranged from 3 to 6.5 pounds per square inch, which corresponded to NaK flows of 20,000 to 33,000 pounds per hour, respectively. Author

N67-35618# Institute of Gas Technology, Chicago, Ill. IIT Center.
LOW-COST ACID FUEL CELL STACKS Progress Report, Oct. 13, 1966–Apr. 13, 1967
B. S. Baker, D. Fisher, D. K. Fleming, J. Meek, S. S. Randhava et al Apr. 1967 46 p
(Contract DAAK-02-67-C-0063)
(AD-654522)

In the first phase of this project, emphasis was placed on equipment modification and operation of fuel cell stacks. Over 2600 hours of stack testing time have been accumulated at 200 F and 250 F. Equipment and supplies for the breadboard reformer and fuel cell system have been ordered, but work has not yet started on this phase of the project. Tests have been conducted with 9 mg/sq cm electrodes to gain familiarity with stack operation at these temperatures and to establish a reference datum for subsequent tests. Reformed, shifted CITE fuel (RSCF) has been tested. Power outputs are lower than with RNG (reformed natural gas) or hydrogen, due to concentration polarization and possibly to increased CO effects. A combination of 5 mg/sq cm anodes and 5 mg/sq cm cathodes has also been tested with the RSCF fuel gas. This electrode combination is comparable to the 9 mg/sq cm electrodes. Tests indicate that 85% H3PO4 is preferable to 100% H3PO4 at 200 F. The higher acid concentration is more suitable at 250 F. Battery stacks operating at 250 F exhibit a performance increase of about 40 mv/cell, compared to stacks at 200 F. However, material degradation is accelerated at the higher temperature. Life testing has been successful at 200 F, and efforts are being made to obtain a corresponding life span for tests at 250 F. Author (TAB)

N67-35653# Army Electronics Labs., Fort Monmouth, N. J.
ORGANIC ELECTROLYTE HIGH DENSITY BATTERIES
Klaus H. M. Braeuer and Jay A. Harvey May 1967 57 p refs
(AD-654813)

The state of the art of high energy density, organic electrolyte batteries has been summarized and reviewed to present the data which has been published in a more convenient, condensed form, and to pinpoint the problem areas on which future work should be concentrated. The report encompasses work which was published during the period 1962 to October 1966, and which was sponsored either by the US Government or by industrial companies and made available to the public. The material in this report is organized as follows: (1) selection of anode-cathode couples, (2) selection of battery components including electrolytes, half-cell systems, and separators, (3) design and performance of experimental cells, and (4) problem areas and areas of future work. Author (TAB)

N67-35716# Radio Corp. of America, Harrison, N. J. Thermoelectric Products Engineering.
DEVELOPMENT OF A 100 WATT THERMOELECTRIC GENERATOR Final Report, 1 Jul.–31 Dec. 1966
H. P. Van Heyst and Robert C. Fortin Jun. 1967 55 p refs
(Contract DA-28-043-AMC-02444(E))
(ECOM-02444-F; Rept.-1; AD-654787)

An investigation was made to determine the feasibility of mating the BMI, multifuel ultrasonic atomizing burner with the RCA, SiGe thermoelectric converter into a 100 watt generator. A test unit was constructed and tests were run from which were projected the elements of a system capable of delivering 100 watts, net, up to operating elevations of 10,000 feet as required by SCL-7777. The work resulted in the following major conclusions: (1) A multifuel, 100 watt (net), thermoelectric generator operating to 10,000 feet is feasible. (2) The RCA thermoelectric structure, with minor modification, is fully adequate. (3) Further burner development is needed to improve ignition, eliminate smoke during start-up and to optimize the system. (4) The weight and volume requirements of SCL-7777 will be exceeded by approximately 50%. Author (TAB)

N67-35759*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
THEORETICAL PERFORMANCE OF SOLAR CELL SPACE POWER SYSTEMS USING SPECTRAL DISPERSION. II: DISPERSION BY DIFFRACTION GRATINGS
Thomas M. Klucher Washington, NASA, Sep. 1967 25 p refs
(NASA-TN-D-4157) CFSTI: HC$3.00/MF$0.65 CSCL 10A

This report presents a simplified theoretical analysis of a system employing concentrating mirrors and diffraction gratings to disperse and to distribute the sun's incident power to a suitable array; the array composed of the semiconductor materials, germanium, silicon, indium phosphide, gallium arsenide, cadmium telluride, and gallium arsenide phosphide, was arranged to convert the sun's energy over the wavelength range 0.3 to 1.5 microns. Two grating configurations in the dispersed light system were studied: one had a concave grating and the other had a plane grating. This analysis shows that such a system, suffering no losses in the optical system, could exhibit a conversion efficiency which is 1.2 to 1.8 times that attainable from an optimum conventional array throughout the temperature range 0° to 150°C. Reflection and diffraction losses reduce the efficiencies of the dispersed light system considerably. The plane grating configuration shows no advantage over the conventional array. The concave configuration does exceed the theoretical 26-percent conversion efficiency for the conventional array, with theoretical efficiencies of 28 to 35 percent for the dispersed light system at the lowest operating temperatures. Author

N67-35760*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
THEORETICAL PERFORMANCE OF SOLAR-CELL SPACE POWER SYSTEMS USING SPECTRAL DISPERSION. I: DISPERSION BY PRISM REFLECTOR
Anthony R. Ratajczak Washington, NASA, Sep. 1967 26 p refs
(NASA-TN-D-4156) CFSTI: HC $3.00/MF $0.65 CSCL 10C

The concept of using dispersed solar energy to power solar cells that have spectral responses matched to particular portions of the solar spectrum was analyzed. The analysis was divided into several parts: the prism reflector, the refraction losses and the effect of the sun's cone of light on the dispersed beam, and an estimate of the overall system energy-conversion efficiency using hypothetical solar cells. The analysis revealed that maximum dispersion is attended by a large loss in optical system efficiency. The approximate overall optical efficiency of a collector and a prism-reflector element, which produces near maximum dispersion, is 56 percent. In spite of optimistic assumptions regarding both the quality of the spectral light reaching the cells and the efficiencies of the various cells, the array conversion efficiency was calculated to be only 14 percent. Thus, the combined efficiency of the optical system (56 percent) and the solar-cell array (14 percent) yields an overall system efficiency of only about 8 percent. Such a concept, therefore, offers no improvement over present day white-light solar-cell arrays, which are about 9 percent efficient in space. Author

N67-35793*# General Electric Co., Philadelphia, Pa. Missile and Space Div.
AUXILIARY POWER SYSTEMS FOR A LUNAR ROVING VEHICLE
E. P. Erlanson Washington, NASA, Aug. 1967 296 p ref
(Contract NAS3-7627)
(NASA-CR-784; Rept.-66SD4395) CFSTI: HC $3.00/MF $0.65 CSCL 10A

Five types of power systems are considered for use with a two man lunar roving vehicle for a 45-Day Mission. Life support and cabin environmental control system conceptual designs are investigated. The benefits of thermal intergration of the power and life support system are determined. Comparisons of nonintegrated and integrated designs are made to determine the combination with the most merit. An integrated isotope Brayton cycle—life support system is selected as the one with the most potential for use with the roving vehicle. Author

N67-35868# Burgess Battery Co., Freeport, Ill.
DEVELOPMENT OF C/ZN BATTERIES CAPABLE OF STORAGE UP TO 160°F Final Report, 1 Jul. 1966–31 Mar. 1967
Terry G. Messing Jun. 1967 50 p
(Contract DA-28-043-AMC-02391(E))
(ECOM-02391-F; Rept.-2; AD-655000)

Discussion of the development of a carbon zinc battery capable of prolonged storage at high temperatures is given. A summary of the ability of the present product is submitted. An analysis of the merits of geometric considerations is given, and data presented to show the capabilities of various cell constructions. Author (TAB)

N67-35934* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
ATS-I SOLAR CELL RADIATION DAMAGE EXPERIMENT, FIRST 120 DAYS
Raymond C. Waddel Aug. 1967 39 p
(NASA-TM-X-55908; X-710-67-412) CFSTI: HC $3.00/MF $0.65 CSCL 10A

The voltage–current characteristics of 30 silicon solar cells having different base resistivities, dopants, shield materials, shield thicknesses and filters were monitored in orbit. The launch procedure, which involved one and one-half ellipses of perigee 100 nautical miles and apogee 19,300 nautical miles, caused severe damage to all unshielded cells; other cells bearing shields from 1 mil to 60 mils in thickness suffered no such damage. After attaining synchronous orbit at 19,300 nautical miles all cells suffered degradation. In 120 days all shielded cells dropped in maximum power from 4.5 to 11 percent. Tentative conclusions include: a base resistivity of 10 ohm-cm is optimum, a shield thickness of 6 mils of silica is optimum, conventional cells are superior to graded base (drift-field) cells, type 7940 silica shields are superior to type 0211 glass shields, a damage mechanism (possibly shield darkening) other than particle damage to the cell was present which led to an optimum shield thickness other than maximum. Author

N67-35981*# Electro-Optical Systems, Inc., Pasadena, Calif.
HYDROGEN–OXYGEN ELECTROLYTIC REGENERATIVE FUEL CELLS, 1 FEBRUARY–1 MARCH 1967
Robert F. Astrin and Martin G. Klein 10 Mar. 1967 24 p
(Contract NAS3-2781)
(NASA-CR-88204; EOS-4110-MF-33) CSCL 10A

The progress made on the development of a hydrogen/oxygen (H_2/O_2) regenerative fuel cell (secondary battery) is reviewed. Primary emphasis was placed on the testing of single cells with matrix structures of pasted potassium titanate (KT)/Teflon membranes sandwiched in KT/asbestos and KT/polypropylene and 100% KT mats in order to extend cycle life. Variables in fabrication techniques of the pasted KT/Teflon membrane were explored in the laboratory, resulting in development of a new KT/Teflon structure. Membrane screening tests utilizing both the bubblethrough cell and impedance cell were performed, and a six-cell test unit was assembled. Author

N67-35993# Royal Aircraft Establishment, Farnborough (England).
PROPOSAL FOR THE UNAMBIGUOUS DISPLAY OF A QUANTITY OVER A WIDE RANGE BY MEANS OF CONTRA-MOVING POINTER AND SCALE
H. R. Hopkin Dec. 1966 24 p
(RAE-TR-66384; AD-654752)

A principle is described according to which a pointer and scale arrangement can have unambiguous readings (because there is a unique pointer position for each reading), and at the same time the scale can cover a wide range of values without a sacrifice of sensitivity. Movement of both pointer and scale relative to the instrument case is proposed, and the design should be straightforward for a linearly moving tape scale. Difficulties arise for circular scales, since a compromise may be required on the orientation of calibration figures, and these are discussed and illustrated. It is noted that a display working on this principle could be valuable for aircraft flight instruments and many other applications, but these possibilities are not examined in detail, and engineering designs are not explored. Author (TAB)

N67-36012*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
STATIC PARASITIC SPEED CONTROLLER FOR BRAYTON-CYCLE TURBOALTERNATOR
John L. Word, Raymond L. E. Fischer, and Bill D. Ingle Washington, NASA, Sep. 1967 23 p refs
(NASA-TN-D-4176) CFSTI: HC $3.00/MF $0.65 CSCL 10C

A static parasitic loading speed-controller design is presented with supporting experimental data obtained from a breadboard model. The speed controller was designed to be used with the turboalternator in a 400-hertz Brayton-cycle energy-conversion system. The speed controller consists of three separate channels, each of which senses frequency from separate phases of the turboalternator and controls the power to a three-phase parasitic load. Each channel comprises a frequency discriminator, a magnetic preamplifier, and three output stages consisting of silicon-controlled

rectifiers and their magnetic firing circuits. The power dissipated in the parasitic load is determined by phase control of the multiple silicon-controlled-rectifier output stages. An overspeed subcircuit ensures that full parasitic power will be maintained should an overspeed condition occur. The speed controller is designed to operate normally from 50 to 200 percent of rated speed and from 50 to 140 percent of rated voltage. Using silicon-controlled rectifiers as the power handling devices enables low shutoff losses to be obtained. Author

N67-36033* Borden Chemical Co., Philadelphia, Pa. Central Research Lab.
IMPROVED SEPARATORS FOR SILVER OXIDE–ZINC AND SILVER OXIDE–CADMIUM CELLS FOR SPACECRAFT APPLICATION
Helmuth L. Pfluger and Howard E. Hoyt Jul. 1967 42 p refs
(Contract NAS5-9107)
(NASA-CR-88131; QR-2) CSCL 10C

The silver barrier properties of membranes being considered for use as separators in silver–zinc and related types of batteries were studied. Membranes which restrict the passage of silver ions from solutions of silver oxide in concentrated potassium hydroxide were of two classes. One type halts the passage of dissolved silver oxide by reducing it to metallic silver which precipitates out on the membrane. The other type limits the rate of silver ion diffusion. No membrane was found with all the desired properties, i.e., chemical inertness, low silver diffusion rate, and low electrolytic resistance. At the 30% level of potassium hydroxide, several membranes showed the same behavior toward silver ion when the electrolyte was saturated with zinc oxide and when it contained no zinc at all. The rate of radioactive silver ion transfer through a nonoxidizable membrane had identical dependence on the initial concentration of radioactivity in the charged half-cell, regardless of whether the opposite half-cell initially contains no silver ion or is saturated with untagged silver ion. R.N.A.

N67-36065* Electro-Optical Systems, Inc., Pasadena, Calif.
HYDROGEN-OXYGEN ELECTROLYTIC REGENERATIVE FUEL CELLS, 1 APRIL–1 MAY 1967
Robert F. Astrin and Martin G. Klein 10 May 1967 28 p
(Contract NAS3-2781)
(NASA-CR-88203; EOS-4110-ML-35) CSCL 10A

This report reviews the progress made on the development of a hydrogen–oxygen (H_2–O_2) regenerative fuel cell (secondary battery). During this period, primary emphasis was placed on the testing of single cells with matrix structures of potassium titanate and teflon. A reference cell was tested. A six cell unit was assembled and is being tested. Author

N67-36112# Mallory (P. R.) and Co., Inc., Burlington, Mass. Lab. for Physical Science.
EVALUATION OF RECHARGEABLE LITHIUM–COPPER CHLORIDE ORGANIC ELECTROLYTE BATTERY SYSTEM Technical Report, Mar. 1966–Mar. 1967
M. L. B. Rao and K. R. Hill 20 Mar. 1967 118 p refs
(Contract DA-44-009-AMC-1537(T))
(TR-2; AD-654451)

The electroformation and discharge of lithium and copper chloride was investigated in half cell and cell configurations in IM LiAlCl4-P.C. The utilization efficiency of lithium in a half-cell depended on the substrate, current density and the loading. In the operation of rechargeable cupric chloride electrodes the tendency of copper salt to form highly soluble chloro cuprate complexes was observed. Impurities present in the solution caused significant self-discharge of the lithium electrode and increased the copper salt solubility. The formation of highly soluble chloro-complexes was a general phenomenon found for other cathodes salts also such as AgCl and $PbCl_2$ in chloride containing electrolytes. This solubility problem affected significantly the Li-$CuCl_2$ cell performance. The transfer of dissolved copper species to the lithium anode by diffusion or migration resulted in the deposition of a copper film on the anode. It was possible to retard the rate of transfer and consequently to improve the 1st discharge of the cell by employing thick separators. At higher current densities passivation of the lithium anode occurred in the cell. The cells were rechargeable but the cycle life was limited due to loss of cathode active material. A course of investigation to effect possible improvements in the cell performance is suggested. Author (TAB)

N67-36186*# American Inst. of Biological Sciences, Washington, D. C. Bioinstrumentation Advisory Council.
BATTERIES—FOR BIOTELEMETRY AND OTHER APPLICATIONS
Larry B. Kuechle (Minn. Univ., Minneapolis) 1 Feb. 1967 18 p Prepared in cooperation with Minnesota Univ. *Its* BIAC Inform. Module M10
(Contracts NASr-132; Nonr-4526(04); AT(11-1)-1332; Grant PHS 5T-AI-188-04)
(AD-654703) CSCL 10C

The improvement of design technique and component reliability during the last several years has made the power source the limiting factor in the design of biological radio-telemetry equipment. Of the many sources available the dry cell is most commonly used and is usually the most economical. This paper briefly describes the characteristics and limitations of the most commonly used primary and secondary dry cells. Familiarity with the operation and design philosophy of the various dry cells will enable the user to select the most suitable cell for a particular application. Also included is a section on thermoelectric cells powered by a radioactive source. TAB

N67-36202# Aerospace Corp., El Segundo, Calif. Materials Sciences Lab.
SOLAR CELL POWER SYSTEMS FOR AIR FORCE SATELLITES
Edwin J. Stofel May 1967 34 p refs
(Contract AF 04(695)-1001)
(TR-1001(2250-20)-7; SSD-TR-67-89; AD-654285)

The U.S. Air Force has used solar cell power systems on various types of satellites. The current methods used for choosing the array, the number of cells, their placement on the solar panels, and the quality assurance tests conducted on the panels are discussed. Author (TAB)

N67-36206*# Hughes Aircraft Co., Los Angeles, Calif.
A STEPPER MOTOR FOR THE SURVEYOR SPACECRAFT
Frank A. Glassow *In* JPL 2d Aerospace Mech. Symp. 15 Aug. 1967 p 15–24 (See N67-36203 21-31)

The high-gain TV transmitting antenna and the solar panel on Surveyor are pointed at the earth and sun respectively by means of a four-axis positioning mechanism. Each axis of the positioner is rotated with a solenoid stepper motor and appropriate reduction gearing for producing adequate torque and step size. The stepper motor employs a unique camming arrangement for converting the linear motion of the solenoid to shaft rotation. Optimization of the magnetic structure and coil characteristics has resulted in a high torque-to-weight ratio as a basic feature of the design. Analysis and intensive development testing resulted in the capability to exceed required performance lvels by a 2-to-1 margin. Conclusions indicate that the stepper motor provides extremely desirable characteristics for space mechanisms. Author

N67-36210*# Fairchild Hiller Corp., Germantown, Md.
DEPLOYABLE SOLAR ARRAY
T. Berry *In* JPL 2d Aerospace Mech. Symp. 15 Aug. 1967 p 51–58 (See N67-36203 21-31)
(Contract NAS5-9658)

A description is given of the development, fabrication, and testing of a deployable solar array for a spin-oriented spacecraft application. The design employs a flexible, roller-mounted substrate which is erected by a linkage extension system. The total array area is 35.5 ft^2. It will fit within a 1.3-ft^3 package, weighs 29 lb, and can be deployed vertically under 1-g conditions. Author

N67-36411*# TRW Systems, Redondo Beach, Calif.
HEAT STERILIZED NICKEL–CADMIUM CELL FAILURE ANALYSIS PROGRAM, PHASE II Final Report
R. F. Fogle [1966] 63 p refs Prepared for JPL
(Contracts NAS7-100; JPL-951092)
(NASA-CR-88128) CSCL 10C

The heat sterilized nickel–cadmium cell failure analysis showed a degradation of cell separator as evidenced by its lower tensile strength. For cells sterilized in the charged or partially charged condition, the degree of separator degradation increased as the state of charge prior to heat sterilization increased. Evidence of nickel electrode degradation due to sterilization was also established. One sterilized cell would not accept a charge during plate testing. This cell's plate potentials showed the nickel electrode to be abnormal. Residues from the leach and plate testing solutions of the failed cell were mainly composed of cadmium hydroxide with intermediate concentrations of calcium carbonate and nickel metal. Chemical analyses of the electrolyte for carbonate and hydroxide content, separator resistivities, and cell AC impedances of all cells tested showed considerable variation, making it difficult to establish trends or correlations between these characteristics and the effects of heat sterilization. Author

N67-36448* Electric Storage Battery Co., Yardley, Pa.
HEAT STERILIZABLE, IMPACT RESISTANT CELL DEVELOPMENT Quarterly Report, Jan. 1–Mar. 31, 1967
G. W. Bodemer, ed. 9 May 1967 65 p Prepared for JPL
(Contracts NAS7-100; JPL-951298)
(NASA-CR-88122; QR-1) CSCL 10C

A high-energy density cell capable of surviving sterilization at elevated temperatures and severe impact shock was developed. Vented, silver oxide-zinc cells containing Compound 323-43 in the unformed, zinc oxide negative, and either RAI-110 or RAI-116 separators were sterilized, put through 60 deep-discharge cycles, and retained more than 50% of their initial capacity. Sterilized cells performed as well as unsterilized controls. Cells which had their cell packs sterilized and cases later sealed showed good capacity retention through 30 cycles when RAI-110 was used as a separator. Similar cells using RAI-116 showed failure in 20 cycles or less. The beginning of a new task concerning cycling, standing then cycling, and floating sealed, sterilized silver-cadmium cells made with RAI-116 type separator is also reported. R.U.

N67-36500*# Texas Instruments, Inc., Dallas.
Semiconductor-Components Div.
DESIGN AND DEVELOPMENT OF 100VA INTEGRATED STATIC INVERTER Final Report, Jun. 1966–Jun. 1967
(Contract NAS8-11925)
(NASA-CR-88274; TI-03-67-60) CSCL 10A

The 100-VA direct-coupled inverter is a 28-volts-dc to three-phase, 400 Hz sine wave inverter that uses a unique matrix of power switches to achieve the desired step-approximated waveshapes. Because of the unique arrangement of power switches, no transformers are required in the inverter itself, thus eliminating the need for those components usually considered the largest and heaviest of all inverter components. The complete inverter does use one transformer, however, in the switching regulator portion. Author

N67-36552*# Thermo Electron Engineering Corp., Waltham, Mass.
HEAT PIPE THERMIONIC CONVERTER DEVELOPMENT Quarterly Report, 11 Jan.–30 Apr. 1967
Apr. 1967 28 p Prepared for JPL
(Contracts NAS7-100; JPL-951465)
(NASA-CR-88119; TE-4067-113-67; QR-3) CSCL 10A

Heat pipe models used for thermionic converters were fabricated and tested for leaks and for temperatures along the walls (using thermocouples). Temperature and electric resistivity data are presented in both tabular and graphic form. Metallographic and X-ray analyses were also used to check for failure. L.S.

N67-36678# Royal Aircraft Establishment, Farnborough (England).
MOMENTUM UNLOADING SYSTEMS: DESIGN OF MAGNETIC ACTUATORS
J. K. Abbott *In* ESRO Control and Stabilization of Spacecraft Vol. III: Active Control Systems Jan. 1967 p 187–199 refs (See N67-36669 21-31)

After a brief mention of jet systems and their disadvantages, the general principle of using interaction with the earth's magnetic field is explained. The design of suitable magnetic actuators is then discussed; these consist of three orthogonally mounted coils, which may be either air-cored or cored with material of high permeability. Various methods of effecting magnetic unloading are described. Author (ESRO)

04 BIOSCIENCES

Includes aerospace medicine, exobiology, radiation effects on biological systems; physiological and psychological factors. For related information see also: 05 Biotechnology.

N67-35314# Bucknell Univ., Lewisburg, Pa.
FEAR OF FAILURE AND AUTONOMIC RESPONSIVITY IN ACHIEVEMENT SITUATIONS
Robert I. Fischer and Richard C. Teevan 1967 30 p refs
(Contract Nonr-3591(01))
(TR-24; AD-654475)

Nineteen Ss were operationally defined as high fear of failure (FF) and 19 Ss as low FF on the basis of the Hostile Press scoring system of the TAT (Birney, Burdick, + Teevan, 1964). Their heart rates were measured in individual testing sessions designed to create a stressful situation in which the stress was related to achievement motivation. It was hypothesized that since high FF individuals defend against the perception of their own failure by projecting their inadequacies onto the environment, they would react to stress with patterns of autonomic responsivity similar to those of Anger-out individuals (as defined by Funkenstein, King, + Drolette, 1957). The results showed that there were no mean differences between the high and low FF groups in terms of their autonomic responsivity to stress although the high FF group was significantly more variable in heart rate levels than the low FF group. The results were interpreted in terms of the possible defensive postures available to the high FF individual in achievement situations. Author (TAB)

N67-35479# Pennsylvania Univ., Philadelphia. Electromedical Div.
THE MEASUREMENT OF THE COMPLEX DIELECTRIC CONSTANT OF PROTEIN SOLUTIONS AT ULTRAHIGH FREQUENCIES: DIELECTRIC PROPERTIES OF HEMOGLOBIN BOUND WATER

Bernard E. Pennock (Ph.D. Thesis) [1967] 368 p refs
(Contract Nonr-551(52); Grants NIH T01-GM-00606; NIH HE-01253)
(Rept.-68-01 ONR-TR-14; AD-655127)

A report is given of work undertaken to relate the measured values of the complex dielectric constant of the globular protein, hemoglobin, in solution, to certain structural features of the hemoglobin molecule (namely water bound to the surface and polar side chains extending out from the surface). Author (TAB)

N67-35537# Zaret Foundation, Inc., Scarsdale, N. Y.
OPHTHALMIC HAZARDS OF MICROWAVE AND LASER ENVIRONMENTS Annual Progress Report, 1 Jun. 1966–31 May 1967
Milton M. Zaret 31 May 1967 12 p
(Contract DA-49-193-MD-2592)
(AD-654523) CFSTI: HC$3.00/MF$0.65

The purpose of this investigation is to determine the nature and scope of radiation hazards and to recommend the requisite parameters for health-safety. For both microwave and laser radiation, ophthalmic pathology is the most sensitive indicator of injury. Threshold changes are produced in the lens with microwave radiation and in the retina with laser radiation. As the threshold lesions are not obvious in routine ophthalmic examination, special techniques are under development not only to permit discovery of the earliest occurrence of the injury but also to document the findings. Author (TAB)

N67-35613*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
A REVIEW OF SOME EXPERIMENTS ON THE SYNTHESIS OF "JEEWANU"
Linda D. Caren and Cyril Ponnamperuma Washington, NASA, Sep. 1967 8 p refs
(NASA-TM-X-1439) CFSTI: HC$3.00/MF$0.65 CSCL 06C

A critical assessment is presented on the data from experiments conducted to synthesize inorganic and organic living globules, called jeewanu. One organic group was produced photochemically; the other was prepared from thermal polymers of amino acids. Although the properties attributed to the jeewanu include growth, multiplication, and metabolic activity, it was concluded that objective, definitive experiments were not performed, and that insufficient evidence was advanced to prove that jeewanu are alive. M.G.J.

N67-35654# Michigan Univ., Ann Arbor. Sensory Intelligence Lab.
A PSYCHOPHYSICAL STUDY OF INTERPRETATION OF PHYSIOLOGICAL RECORDINGS Final Technical Report, 1 Apr. 1964–28 Feb. 1966
Wilson P. Tanner, Jr. May 1967 21 p refs
(Contract DA-49-193-MD-2585)
(AD-654441) CFSTI: HC$3.00/MF$0.65

Studies were conducted on the ability of observers to read records of physiological character. The records were constructed of signals added to noise, with both the signal and noise designed to be similar to conditions frequently encountered in physiological recordings. The observer was presented with a trace on an oscilloscope which was generated either by signal plus noise, or by noise alone. He was asked to state whether the trace contained the signal or contained only noise. During the studies he was not permitted to see the signal without the noise. After each decision, the observer was told if he was right or wrong. In the first of two experiments, the signal had no uncertain parameters, while in the second, the signal had a relatively small starting time uncertainty. ROC curves were obtained by changing the bonus payoff schedule for the observer. Under fixed signal conditions, d, the index of detectability, was independent of drastic changes in the observers criterion. In the second experiment, the slight uncertainty in starting time was reflected in a shift of the slope of the ROC curve. The change in slope was indicative of increased variance in the S + N distribution of events. Author (TAB)

N67-35755 Nuklearni Institut Jozef Stefan, Ljubljana (Yugoslavia).
FAST NUCLEAR MAGNETIC RESONANCE SELECTION METHOD IN PLANT BREEDING FOR HIGHER OIL CONTENT
I. Zupancic, S. Vrscaj, J. Porok, I. Levstek, V. Erzen et al Apr. 1967 8 p refs
(NIJS-R-500)

A new wide line nuclear magnetic resonance (NMR) technique for the fast, selective, and inexpensive determination of oil content in single kernel samples of maize and sunflower seeds is described. In this method the selection decisions are based on the properties of individual kernels and not on population averages, the kernels are neither destroyed nor biologically damaged during the analysis, and a large number of samples can be analyzed in a short period of time. This method also has higher speed and selectivity than the conventional wide line NMR method. The selectivity of the method is based on the different degree of mobility of the various hydrogen containing constituents of plant seeds. R.N.A.

N67-35782# Naval Radiological Defense Lab., San Francisco, Calif.
EFFECTS OF ULTRAVIOLET LIGHT IRRADIATION AND HEAT SHOCKS ON CELL DIVISION IN SYNCHRONIZED TETRAHYMENA
A. C. Giese (Stanford Univ.) and D. Stuart Nachtwey 24 May 1967 28 p refs Prepared jointly with Stanford Univ.
(Grant PHS-C-3461)
(USNRDL-TR-67-58; AD-654715)

The division of synchronized Tetrahymena pyriformis (strain W) irradiated with low doses of ultraviolet light is delayed if the irradiation is administered during the first 30 minutes after the end of the synchronizing treatment. After a short period of transition, division in most cells is not delayed even by relatively high doses. The delay induced by a particular low dose administered at any time up to the transition to insensitivity is essentially constant. The division of synchronized cells is delayed by heat shocks (34 plus or minus 0.1C, for 20 minutes) applied at any time up to approximately 60 minutes after the end of the synchronizing treatment. After this time, for any single cell in a sample, there is an instantaneous transition to heat-shock insensitivity. The delays in cell division induced by heat shocks increase with time from the end of the synchronizing treatment, attaining a maximum just before the transition to insensitivity. The two different transition times in the responses of synchronized cells to UV and to heat shock are interpreted as representing the completion of two different processes in the final preparation of the cells for division. The qualitative and quantitative differences between the responses to UV and to heat shock suggest that two different substances are involved, one sensitive to UV and one to heat. Some evidence is presented that suggests that the completion of the heat-sensitive process depends upon the UV-sensitive process. Author (TAB)

N67-35845# Atomic Energy Establishment, Winfrith (England). Radiological and Safety Div.
USE OF ULTRASONICS TO INVESTIGATE SOFT TISSUE THICKNESSES ON THE HUMAN CHEST
D. Ramsden, C. O. Peabody, and R. G. Speight Mar. 1967 18 p refs
(AEEW-R-493) CFSTI: HC$3.00/MF$0.65

The measurement of soft tissue thicknesses over the chest of nineteen male subjects using an ultrasonic probe is described. The apparatus and techniques are briefly described. The results are tabulated, and correlations of the mean soft tissue thicknesses with various combinations of body parameters are given. Variations in the distribution and amount of soft tissue between the chests of individuals mean that large corrections must be applied to results obtained from in vivo estimation of ^{239}Pu and ^{241}Am in the human lung. The best correlations obtained enable the mean soft tissue thickness to be predicted to within 0.2 cm (95% confidence limit) from a knowledge of the individuals weight, height and chest circumference. The corresponding error in an estimation of ^{239}Pu in the lung would be ±20%. NSA

N67-35903# Defence Research Board, Ottawa (Ontario).
CONTENT OF AMINO-ACIDS IN THE DIFFERENT AREAS OF THE BRAIN UNDER CONDITIONS OF HYPEROXIA
T. N. Pogorelova May 1967 5 p refs Transl. into ENGLISH from Dokl. Akad. Nauk SSSR (Moscow), v. 167, no. 6, 1966 p 1421–1422
(T-483-R) CFSTI: HC $3.00/MF $0.65

The content of free amino-acids in the different areas of the brain was investigated in rabbits during the pre-paroxysmal and paroxysmal phases of the effect of oxygen under pressure. In rabbits exposed to oxygen at 6 atm pressure the paroxysms began within 12 to 18 minutes. The amino-acid composition of brain areas was studied by a combined electrophoretic and chromatographic method. In the hemispheres and the thalamus the total content of amino-acids was higher than in other areas of the brain. The various amino acids present in the brain during hyperoxia are tabulated. S.P.

N67-35921*# National Aeronautics and Space Administration, Washington, D. C.
INFLUENCE OF FREQUENCY, NUMBER, AND LOCUS OF STIMULI ON THE INTENSITY DEPENDENCE OF VIBRATORY EVOKED CORTICAL RESPONSE IN MAN
H. Fruhstorfer Aug. 1967 60 p refs Transl. into ENGLISH of the book "Der Einfluss von Reizfolgefrequenz, Reizanzahl, und Reizort auf die Intensitaetsabhaengigkeit Vibratorisch Ausgeloester Corticaler Antworten Beim Menschen" Erlangen, Univ., (W. Germany), 1966 92 p
(NASA-TT-F-11193) CSCL 06P

The variables influencing the relation between stimulus and averaged cortical response, such as adaptation, fatigue, and habituation, are discussed. The area of the potential waves is investigated, indicating that this represents a criterion for the ion shift during the synchronized data processing of a cerebral functional unit. The discontinuity of the intensity function of cortical response to vibratory stimuli of the fingertips, located about 40 db above the threshold of sensitivity, is interpreted as a proof for the existence of two receptor populations of differing sensitivity. It is found that the latency is not so much a function of the number of neurons passed but a manifestation of data processing of differing duration. The vibratory evoked potentials decreased with increasing frequency of stimulus application, differing from findings for other sensory systems. Author

N67-35989* Oregon State Univ., Corvallis.
AMMONIFYING, NITRIFYING, AND SULFUR OXIDIZING CAPACITY OF CHILE DESERT SOILS Progress Report
W. B. Bollen and Fred Au 31 May 1967 12 p refs Prepared for JPL
(Contracts NAS7-100; JPL-950983)
(NASA-CR-88021) CSCL 06M

Methods are described and results given for a soil fertilization program based on microbial activity in releasing plant nutrients in desert soils. Most of the arable soil samples studied displayed at least 50% ammonification. One of the soils gave 73% nitrification. Within limits of experimental error, other soils showed no nitrification. This lack is attributed not only to salinity but also to pH values above the threshold value for nitrite formation in soils. All of the soil samples investigated are low in sulfur oxidizing capacity. Data tables presented on Chile desert soil properties include: detritus, moisture, and water-holding capacities; and summaries of ammonification, nitrification, and sulfur oxidation capacities. E.C.

N67-36006# Philco Corp., Willow Grove, Pa. Biomedical Engineering Lab.
MYOPOTENTIAL PATTERNS AND EXTERNAL CONTROL: EFFECTS OF PRACTICE AND FATIGUE, AUGUST 1, 1965–JULY 31, 1966
Roy W. Wirta, Kevin A. Cody, and Ray F. Finley 31 May 1967 38 p ref
(Contract Nonr-4292(00))
(AD-655140)

A motor performance test was devised to ascertain myoelectric response associated with practice and fatigue effect. Five subjects participated in the study over a period of three weeks during which practice and test sessions were uniformly spaced. Using performance times as a criterion measure of proficiency, associated myoelectric data were correlated to determine total electrical energy output and synergic pattern relationships. Results revealed individual responses, but in general, also revealed an increase in total electrical energy output when performance times were significantly reduced. Except during post-fatigue tests, there was no absolutely repeatable pattern (relative ranking by amplitudes) of the multiple contracting muscles. Author (TAB)

N67-36045# Air Force Systems Command, Brooks AFB, Tex. Arctic Aeromedical Lab.
THE COMBINED EFFECTS OF COLD AND EXERCISE ON THE TRICEPS SURAE REFLEX
Jack H. Petajam and Charles J. Eagan May 1967 20 p refs
(AAL-TR-66-15; AD-655069)

The one-half relaxation time (1/2 RT) for the triceps surae reflex was studied in four subjects after five-minute runs at 134 m/min (5 mi/hr) on a treadmill set at 10% grade. This exercise decreased 1/2 RT to 90% of normal. Cooling by immersion to the neck for 60 min in a stirred 30C bath enhanced the exercise effect on 1/2 RT (decreased it to 87%) whereas cooling alone lengthens the relaxation phase. Eight highly-fit athletes (U. S. Biathlon Team) who exercised at the higher level of 5 min at 188 m/min (7 mi/hr) and 8.6% grade, showed a greater effect on 1/2 RT: a decrease to 83% of the pre-exercise value. The shortening of relaxation time by exercise appears to be a warm-up phenomenon related to local metabolic changes in muscle which, paradoxically, are enhanced by whole-body cooling. Author (TAB)

N67-36088# School of Aerospace Medicine, Brooks AFB, Tex.
EFFECT OF MENTAL EXERCISE ON PAROTID FLOW RATE IN THE HUMAN
Ira L. Shannon Apr. 1967 12 p refs
(SAM-TR-67-36; AD-654293)

Three experiments were carried out in which paired parotid fluid samples were collected from 225 healthy young adults in an effort to ascertain the effect of mental exercise on rate of flow. Samples were collected without exogenous stimulation and with paraffin and sugared chewing gum employed as eliciting agents. Mental exertion involved adding columns of whole numbers four digits wide and four digits in height. Subjects were sampled that

performed no arithmetic computations, others that solved problems during the second collection interval, while others performed the computations while providing the initial sample. There was no indication in any of the 3 experiments that mental concentration produced a significant effect on the rate of parotid flow.

Author (TAB)

N67-36123*# National Aeronautics and Space Administration, Washington, D. C.

STUDY OF THE CUMULATIVE EFFECT OF IMPACT ACCELERATIONS [ISSLEDOVANIYE KUMULYATIVNOGO DEYSTVIYA UDARNYKH PEREGRUZOK]

S. A. Gozulov, N. P. Morozova, and V. A. Elivanov Aug. 1967 7 p refs Transl. into ENGLISH from Kosmich. Biol. i Med. (USSR), v. 1, no. 2, 1967 p 22–26

(NASA-TT-F-11134) CFSTI: HC $3.00/MF $0.65 CSCL 06C

Experiments on rats were performed to study the cumulative effect of impact accelerations of 600 g revealed at postmortem examinations. The accelerations were applied at different intervals and subcritical landing velocities. The cumulative lesions resulting from repeated exposures with an hour interval were detected as the primary lesion of the lungs similarly to the effect of a single exposure at supercritical velocities. Lesions developed after a comparatively small number of repeated exposures (3 to 5) for a wide range of subcritical velocities (7 to 4–5 m/sec). The aftereffect period covers over 24 hours and is related to reactive changes in individual organs. Author

N67-36129# Joint Publications Research Service, Washington, D. C.

SIMULATION IN BIOLOGY AND MEDICINE

V. M. Glushkov, ed. et al 3 Aug. 1967 44 p refs Transl. into ENGLISH of the book "Modelirovaniye v Biologii i Meditsine" Kiev, Nauk.-Dumka, no. 2, 1966 p 6–40, 75

(JPRS-42066; TT-67-32696) CFSTI: HC $3.00/MF $0.65

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N67-36130# Joint Publications Research Service, Washington, D. C.

POSSIBILITIES AND PROSPECTS OF SIMULATION OF MENTAL FUNCTIONS

N. M. Amosov *In its* Simulation in Biol. and Med., 3 Aug. 1967 p 1–7 (See N67-36129 21-04)

In a study of mental functions, the human brain is likened to a computer. The definition of simulation is given as any cognitive process, and a model is defined as any structure in which the information about the structure and function of another system is reflected. Computer programming and information processing for the cortex are discussed. It is suggested that the creation of an artificial brain must be constructed on other principles, in cooperation with psychologists, physiologists, and mathematicians. R.U.

N67-36131# Joint Publications Research Service, Washington, D. C.

THE MEMORY PROBLEM IN NEUROPHYSIOLOGICAL AND BIOCYBERNETIC ASPECTS

K. A. Ivanov-Muromskiy and E. T. Golovan *In its* Simulation in Biol. and Med., 3 Aug. 1967 p 8–13 refs Presented at 2d All-Union Conf. on Neurocybernetics, Oct. 1965 (See N67-36129 21-04)

A general discussion is presented of the basic prerequesites for simulation of human memory in the light of certain assumptions of neurophysiology and biocybernetics. Some arguments are briefly outlined on the model simulating the human memory. R.U.

N67-36132# Joint Publications Research Service, Washington, D. C.

DYNAMICS OF IONIC CONDUCTANCES OF THE NERVOUS MEMBRANE

Yu. G. Antomonov *In its* Simulation in Biol. and Med., 3 Aug. 1967 p 14–21 refs (See N67-36129 21-04)

An attempt is made to describe the experimental facts obtained by Hodgkin–Huxley in a new way and confirm the correctness of the new mathematical interpretation of the dynamics of the ionic components by calculations and simulation. R.U.

N67-36133# Joint Publications Research Service, Washington, D. C.

THE IONIC THEORY OF EXCITATION OF NERVE TISSUE

A. B. Kotova *In its* Simulation in Biol. and Med., 3 Aug. 1967 p 22–28 refs (See N67-36129 21-04)

Open literature sources are briefly reviewed on the ionic theory of excitation of nervous tissue. Two hypotheses are assumed and outlined: (1) The total conductance of the membrane depends on the difference in the conductances with respect to the ions passing through the membrane from inside to outside and the ions passing through the membrane from outside to inside the nerve fiber (cell). (2) The process of generation of the spike potential is unstable in nature and takes place in accord with the principle of systems with positive feedback. R.U.

N67-36134# Joint Publications Research Service, Washington, D. C.

FEEDBACK IN THE BIOELECTRICAL CONTROL SYSTEM FOR THE MOVEMENTS OF MAN

L. S. Aleyev and S. G. Bunimovich *In its* Simulation in Biol. and Med., 3 Aug. 1967 p 29–34 refs (See N67-36729 21-04)

Feedback in the creation of technical systems for the control of the active motions of man is briefly considered. These active motions of humans are a complex process in which a large number of functional units participate. The control information comes from the central divisions of the nervous system to the servomechanisms of the organism (the muscles), being subject to correction at various stages of the passage. A block diagram of a multichannel control device with feedback circuits of the bioelectro-location type is depicted. R.U.

N67-36181*# Scientific Translation Service, La Canada, Calif.

ACCLIMATIZATION [ACCLIMATISATION]

R. Virchow Washington, NASA, Jul. 1967 13 p refs Transl. into ENGLISH from Z. Ethnologie (Germany), 1885 p 202–214 (Contract NASw-1496)

(NASA-TT-F-11147) CFSTI: HC $3.00/MF $0.65 CSCL 06P

Acclimatization of Europeans to hot climates is discussed. Experience in Algeria, Africa, Australia, Micronesia, and other places is described. A differentization is made between acclimatization of the individual and the race. Author

N67-36187*# American Inst. of Biological Sciences, Washington, D. C. Bioinstrumentation Advisory Council.
A SURVEY OF *IN VIVO* ENERGY SOURCES
J. J. Konikoff (GE, Valley Forge, Pa.) 1 May 1967 22 p refs Prepared in cooperation with General Electric Co. *Its* BIAC Inform. Module M9
(Contracts NASr-132; NAS2-140; Nonr-4526(04))
(AD-654702) CSCL 06B

Recent engineering advances in medicine have permitted the application of various protheses for the correction of physiological defects. Such devices as cardiac pacemakers, diaphragm stimulators, and artificial limbs have been greatly improved in effectiveness. Long term implants of electronic gadgetry have also become relatively commonplace in the biomedical community as a means for measuring several physiological parameters in situ. In both cases cited above, the power supply plays a vital role--because of its impact on the volume and life of the device. Although miniature batteries are doing an effective job in these applications, their two- or three-year life requires surgical procedure for replacement. To reduce this, other energy sources are being investigated. One approach is to use the body during its normal functioning to drive an electric power source. Bioelectric potentials, muscle motions, and implanted fuel cells are some of the approaches being investigated with varying degrees of success. (Another approach is to transmit the power through the skin by inductive coupling or in the form of radio frequency energy. This technique relieves the problems of battery life since the power pack is external and can be easily replaced.) Author (TAB)

N67-36407# Aerospace Medical Div. Arctic Aeromedical Lab., Fort Wainwright, Alaska.
THE EFFECTS OF LOW MOLECULAR WEIGHT DEXTRAN ON CARDIOVASCULAR AND METABOLIC PARAMETERS IN DOGS Technical Report, Jan.–Mar. 1967
Eugene Evonuk and Francis J. Sullivan Jun. 1967 18 p refs
(AAL-TR-67-8; AD-655070)

Two series of experiments were carried out to determine the species specificity and some cardiovascular and metabolic responses to infused LMD (low molecular weight dextran, 40,000) in dogs. Cardiac output, limb blood flow arterial pressure, heart rate, hematocrit, circulating histamine levels, O2 consumption, CO2 production, and respiratory minute volume were measured prior to and at various intervals after LMD infusion. The infusion of LMD resulted in a marked increase in limb blood flow, cardiac output, O2 consumption, and CO2 production, a decrease in hematocrit, systemic and peripheral resistance, with no significant change in mean arterial pressure, heart rate, and circulating histamine levels. In dogs, these responses were, for the most part, in the opposite direction from those observed in the rat, and a species variability to infused LMD was indicated. It was concluded that the marked increase in peripheral blood flow was due to a slight hemodilution, a decrease in resistance with a resultant increased perfusion of blood throughout the entire capillary bed. These findings further support the use of LMD for the improvement of blood flow in some ischemic conditions. Author (TAB)

N67-36424# Technische Hochschule Munchen (West Germany). Fakultaet fuer Allgemeine Wissenschaften.
INVESTIGATIONS CONCERNING SHORT-CHAIN FATTY ACID SYNTHESIS IN *CI TYROBUTYRICUM* [UNTERSUCHUNGEN UEBER KURZKETTIGE FETTSAEURESYNTHESE IN *CL TYROBUTYRICUM*]
Sandra K. Erickson (Ph.D. Thesis) Jul. 1966 66 p refs In GERMAN

Investigated was the incorporation and distribution of tritium in butyric and acetic acids which were formed through fermentation of various substrates in tritium-marked water by *Clostridium tyrobutyricum*. The values were approximately as theoretically expected during the synthesis of acetate by the Embden–Meyerhof method. Tritium incorporation and distribution was also studied in butyric and acetic acids which were synthesized by *Cl. tyrobutyricum* from such other marked substrates as glucose-1-T, glucose-6-T, acetate-2-T, pyruvate-3-T, mannite-2-T, glycerin-2-T, and lactate-2-T. Only a moderate number of back reactions occurred during the incubation of unmarked butyrate and acetate in tritium-marked water with reduced cells. The absolute configuration on C-3 of the butyrate, which is formed by the *Cl. tyrobutyricum* from mannite-2-T, was determined by means of the stereospecific-working propionyl-CoA-carboxylase. Transl. by K.W.

N67-36427# School of Aerospace Medicine, Brooks AFB, Tex. Aerospace Medical Div.
MEASUREMENT OF SERUM IONIC CALCIUM USING A SPECIFIC ION ELECTRODE, AUGUST 1966–JANUARY 1967
Dorothy E. Arnold, Marion J. Stansell, and Harry H. Malvin May 1967 15 p refs
(SAM-TR-67-43; AD-655062)

A recently developed calcium ion electrode was evaluated for use in the routine measurement of serum ionic calcium. The electrode, used in conjunction with an expanded scale pH meter, permits the direct and accurate assay of ionic calcium in fresh serum samples with a minimal expenditure of time and materials. Factors found to be critical to reliable operation include electrode mounting configuration, diluent for the calibration standards, sample preparation, control of pH, uniformity of sample volume and thermostasis. Analytic precision--a function of electrode placement, instrumental stability and readout parallax--is routinely excellent. Discrimination and recovery studies indicate the minimal assayable concentration differences to be between 0.2 and 0.3 mg.%. The electrode appears to be applicable to a wide variety of clinical and nonclinical investigations. Author (TAB)

N67-36478# Johns Hopkins Univ., Baltimore, Md. Dept. of Statistics.
DIFFUSION OUT OF A TRIANGLE
W. Smith and G. S. Watson Jan. 1967 18 p refs
(Contract Nonr-4010(09); Grant NIH GM-1237-04)
(TR-67; AD-654459)

A problem in molecular genetics called for the following result. If a particle is dropped at random on a right-angled isosceles triangle, and thus allowed to execute symmetrical Brownian motion, the chance that it will first leave the triangle via the hypotenuse is 0.41062. An inequality and two methods of deriving this probability are illustrated. The most useful source of solutions to diffusion problems of this kind is the torsion problem of elasticity. Author (TAB)

N67-36480*# National Aeronautics and Space Administration, Washington, D. C.
EXTREMAL FACTORS OF LONG-TERM SPACE FLIGHT AND HEALTH REQUIREMENTS FOR SPACECRAFT CREWS [EKSTREMAL'NYYE FAKTORY DLITEL'NOGO KOSMICHESKOGO POLETA I TREBOVANIYA K SOSTOYANIYU ZDOROV'YA CHLENOV EKIPAZHEY KOSMICHESKIKH KORABLEY]
P. V. Buyanov and V. G. Terent'yev Aug. 1967 4 p refs Transl. into ENGLISH from Kosmich. Biol. i Med. (USSR), vol. 1, no. 2, 1967 p 52–54
(NASA-TT-F-11136) CFSTI: HC$3.00/MF$0.65 CSCL 06S

Medical selection of spacecraft crews for long-duration space missions is discussed. In view of individual differences in functional limits and tolerance to flight factors, it is suggested to base physical aptitude requirements for candidates on the effect of environmental space flight factors upon the human organism and its tolerance limits. Positive selection is predicated on satisfactory resistance to space-simulation tests (acceleration, physical stress, oxygen starvation, orthostatic tests). Author

N67-36527*# Stanford Univ., Calif. Instrumentation Research Lab.

MICROORGANISMS—EXPLORATIONS IN EXOBIOLOGY Status Report, 1 Oct. 1966–1 Apr. 1967

Joshua Lederberg and Elliott C. Levinthall 1 Apr. 1967 98 p refs

(Grant NsG-81-60)

(NASA-CR-88326; IRL-1056) CFSTI: HC $3.00/MF $0.65 CSCL 06M

Technical details for continuing projects in exobiology are summarized. General project areas reported on include: fluorometry, gas chromatography and optical resolution, mass spectrometry, computer managed instrumentation, and atmospheric effects on photographic resolution. These projects contribute to technical mastery of problems in exobiology by furnishing specific analytical techniques of high sensitivity and discrimination for the detection of exotic life. A description of DENDRAL, a computer program used for generating and filtering chemical structures, is appendixed. R.U.

N67-36530# Technische Hochschule Munchen (West Germany). Fakultaet fuer Maschinenwesen und Elektrotechnik.

CONCERNING THE CONDUCTIVITY OF VARIOUS GASES IONIZED WITH TRITIUM BETA RAYS AND USE OF SUCH RAYS AS ATMOSPHERIC ION SOURCES IN THE BIOCLIMATOLOGY [UEBER DIE LEITFAEHIGKEIT VERSCHIEDENER MIT TRITIUM-BETA-STRAHLERN IONISIERTER GASE UND DIE ANWENDUNG SOLCHER STRAHLER ALS LUFTIONENQUELLE IN DER BIOKLIMATOLOGIE]

Umur Buektas (Ph.D. Thesis) 1966 190 p refs In GERMAN

The ionization characteristics of tritium beta rays are studied in air, oxygen, nitrogen, carbon dioxide, and argon. Measured was the dependence of the ionizing current on electric field strength, gas pressure, and gas temperature, and from measurements of the maximum ion yield of tritium sources in dependence from gas pressure it was possible to determine the range of 18 keV-electrons. The measuring method can also be used to obtain information on the energy dependence of the actual range of medium-energy electrons. Other experiments were conducted to determine the bioclimatic effect of atmospheric ions produced by tritium beta rays on several physiological parameters, among them the breathing and pulse frequencies of humans. An improved electronic method and a fully transistorized apparatus were also developed for measurements in these experiments. Transl. by K.W.

N67-36580*# IIT Research Inst., Annapolis, Md.

LIFE IN EXTRATERRESTRIAL ENVIRONMENTS Quarterly Status Report, 31 May–31 Aug. 1967

Aug. 1967 11 p

(Contract NASr-22/14-003-001)

(NASA-CR-88134; IITRI-L6023-10) CFSTI: HC $3.00/MF $0.65 CSCL 06F

Summary experimental results are presented on life processes in simulated planetary environments. *B. cereus* and PA 3679 spore suspensions were heat-shocked at 80°C for 10 minutes just before use. Soil ecology experiments initiated were divided into key, or screening, and testing, or confirmatory types. The effect of 100% carbon dioxide at 5 mb pressure on *S. aureus* is shown graphically. The soil ecology experiments in a simulated Martian environment were conducted to evaluate the minimum moisture and numbers required for growth and survival of the following microorganisms: *Bacillus cereus, Lactobacillus plantarum, Pseudomonas aeruginosa,* Putrefactive Anaerobe (PA 3679), *S. aureus,* and *Streptomyces albus.* R.U.

N67-36613* Oregon State Univ., Corvallis.

SYSTEMATIC DESCRIPTION AND KEY TO ISOLANTS FROM HILGARD SOILS

W. B. Bollen and Karen M. Byers 12 Jun. 1967 111 p Prepared for JPL

(Contracts NAS7-100; JPL-950783)

(NASA-CR-88114) CSCL 06M

Species designations are given for a list of organisms that are isolants from the Hilgard soils. A dichotomous key separates these isolants into four groups, and descriptive charts are arranged in these groups. Each of the charts includes staining and morphological, cultural, and physiological characteristics. Of the 58 surviving isolants, the percentage in each group are as follows: bacillus, 75.9%; soil diphtheroid, 15.5%; actinomycetes, 3.4%; yeast, 1.7%; micrococci, 1.7%, and gram negative, 1.7%. M.W.R.

N67-36658# Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.

BIOPHYSICAL MECHANISMS AND SCALING PROCEDURES APPLICABLE IN ASSESSING RESPONSES OF THE THORAX ENERGIZED BY AIR-BLAST OVER-PRESSURES OR BY NON-PENETRATING MISSILES

I. G. Bowen, E. R. Fletcher, D. R. Richmond, F. G. Hirsch, and C. S. White November 1966 46 p refs

(Contract DA-49-146-XZ-372)

(DASA-1857)

A mathematical model was described that was devised to study the dynamic response of the thorax of mammals to rapid changes in environmental pressure and to non-penetrating missiles impacting the rib cage near the mid-lateral point of the right or left thorax. Scaling procedures for similar animals were described relating, for a given degree of damage, the body mass of the animal to various parameters describing the exposure dose. Internal pressures computed with the model for a dog exposed at the end plate of a shock-tube were compared to those measured with a pressure transducer inserted in the esophagus down to the level of the heart. Computed time-displacement histories of missiles following impact with the right side of the thorax were compared to those obtained experimentally by means of high-speed motion picture photography. High internal pressures predicted with the model for non-penetrating impact were compared to those obtained experimentally and theoretically for exposure to air blast. Experimental data were presented arbitrarily assessing lung damage in animals struck by non-penetrating missiles (constant impact area) as a function of missile mass and impact velocity. These data were compared for several missile mass-velocity combinations with those computed using the mathematical model. Similarities in the dynamic responses of the thorax to air blast and to non-penetrating missiles were discussed. Author (NSA)

05 BIOTECHNOLOGY

Includes life support systems, human engineering; protective clothing and equipment; crew training and evaluation, and piloting. For related information see also: 04 Biosciences.

N67-35308*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
BIOTECHNOLOGY
Paul Foster *In its* Aerospace Related Technol. Conf. for Ind. and Com. 25 May 1967 p 69-85 (See N67-35303 21-15)

Examples of space medical equipment, already being applied on earth, are described. The convenience of spray-on electrodes, for monitoring heart action, to the patient and to the nurse is indicated. Piezoelectric devices for sensing vibrations are applied to the detection of heart beats in chick embryos, muscle tremors, and cranial accelerations. Thermocouples were developed to determine temperature conditions in the brain during cryogenic surgery. A walking chair, design as a lunar walker, is being tested by crippled children. An infrared sensor operated by eye movement is under consideration as control switches for paralyzed persons. An artificial heart system and a photographic technique to bring out fine detail on X-ray pictures are also described. N.E.N.

N67-35365 Joint Publications Research Service, Washington, D. C.
PNEUMATIC INSULATION SUIT FOR RADIOACTIVITY PROTECTION
S. M. Gorodinskiy and V. L. Shcherbakov 13 Jul. 1967 7 p Transl. into ENGLISH from Gigiena i Sanit. (Moscow), no. 5, 1967 p 43-46
(JPRS-41816; TT-67-32448) CFSTI: $3.00

A pneumatically insulated suit with its own system for regenerating air was developed for use under radioactive conditions. The suit, which has a hose to an air supply, is considered 99.9% effective against gases and aerosols. It has minimum dimensions, can be used for a two-hour period in temperatures up to 40° and 45°C, and is easily decontaminated. A cooling suit of bleached moleskin is worn over the insulation suit, which is made of freezeproof polyvinyl chloride plastic reinforced with capron mesh. In effect, the inside of the suit is used as a breathing bag; and no loss of consciousness has been observed in persons wearing the suit. M.W.R.

N67-35374* General Electric Co., Philadelphia, Pa. Missile and Space Div.
BIOSATELLITE ENVIRONMENTAL CONTROL AND LIFE SUPPORT SYSTEM DESIGN
Robert Ebersole, Louis Pochettino, and Walter Kugler [1967] 40 p
(Contract NAS2-1900)
(NASA-CR-73116) CSCL 06K

This paper presents the environmental control and life support system design for the 21 and 30 day mission NASA Biosatellite Program. The biosatellite missions will be flown to investigate the following: (1) twenty-one days for growth and morphological studies, and for metabolic biorhythms; and (2) thirty days for studies of nervous function, behavior, metabolism and cardiovascular function of the primate. Temperature control is provided by a circulating coolant loop which utilizes a 24 ft^2 radiator, liquid-to-liquid and air-to-liquid heat exchangers, temperature control mechanical and electrical valves, and water boiler for peak thermal conditions. A two loop system is described which provides temperature control for the fuel cell power source, cryogenic gases, water and urine storage and the gas management system. The gas management system which provides control of the gaseous environment in the recovery capsule is also described. This system controls temperature, relative humidity, re-circulation and filtration of the atmosphere, build-up of toxic and/or nontoxic gases and odors, and partial and total pressure of the nitrogen/oxygen atmosphere. Comparisons of the experimental results with analytical predictions are presented. Extensive thermal vacuum system testing was performed to verify design predictions. Good agreement with analysis was achieved. Author

N67-35420# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
ON THE ROLE OF A MOTOR LINK IN THE VISUAL SYSTEM IN OBJECT IDENTIFICATION BY ITS OUTWARD CONTOUR [O ROLI MOTORNOGO ZVENA ZRITEL'NOY SISTEMY PRI OPOZNANII OB'YEKTA PO VNESHNEMU KONTURU]
R. M. Granovskaya and V. A. Ganzen 20 Jan. 1967 28 p refs Transl. into ENGLISH from Vopr. Psikhologii (Moscow), no. 1 1965 p 66-81
(FTD-TT-65-1743; TT-67-62294; AD-655051)

The article deals with the proposed methods for solving the problem of identifying visual images. Motor mechanisms of the visual system are discussed. By proceeding from recognition of the role played by the motor link in the process of identifying contour images, the authors intended to design and check a theoretical model of a system that performs this process. Experiments are described and the model is discussed. TAB

N67-35433# General Electric Co., Philadelphia, Pa. Missile and Space Div.
APPLICATION OF PERMSELECTIVE COMPOSITE TECHNIQUES FOR ATMOSPHERE-THERMAL CONTROL OF EMERGENCY AND EXTRAVEHICULAR MANNED SPACE ASSEMBLIES Final Report, May 1965-Aug. 1966
David J. Withey, Edward J. Glanfield, and Clark V. Dohner Wright-Patterson AFB, Ohio, AMRL, Apr. 1967 92 p refs
(Contract AF 33(615)-2850)
(AMRL-TR-66-224; AD-655089)

The program encompasses the analysis, research, design fabrication, and testing of an exploratory laboratory model of an emergency or extravehicular space assembly using permselective membrane techniques for atmosphere control. The purpose of this effort was to develop an advanced concept which would depart from the traditional approach utilized in spacecraft design by transferring most of the atmosphere-thermal control functions from the associated hardware subsystems to the enclosing structure. A silicon rubber permselective composite incorporated into the pressure retention wall of the enclosing structure permits selective permeation of carbon dioxide, water vapor, and contaminant gases to space with minimal oxygen permeation. In addition, the use of superinsulation on the exterior surface of the structure provides passive radiant thermal control. This, in conjunction with the permselective composite material, substantially reduces the weight, volume, and power requirements of environmental control subsystems required for a manned emergency and extravehicular assembly. While the permselectivity of the silicone rubber composite was determined, the final structure was subject to a large amount of leakage. This resulted in the cancellation of the full scale test program and in redirection of the project effort to include a failure analysis to determine the cause and solution to the leakage problem. Author (TAB)

N67-35434# Innsbruck Univ. (Austria).
STUDIES OF ARTIFICIALLY DISTURBED SENSORY COORDINATION IN MAN Final Scientific Report, 1 Mar. 1966-28 Feb. 1967
Franz Thurner 10 May 1967 143 p refs
(Contract AF 61(052)-938)
(AFOSR-67-1548; AD-655128)

Contents: The problem of incongruence--the S-Illusion; The processing of simultaneous visual and kinesthetic signals of directional movement; Comparison of successive visual and kinesthetic signals; Directional judgments with a visual standard and a kinesthetic comparison object; Increasing suppression of kinesthetic signals by training; Kinesthetic comparison of movement

directions; On the dominance of vision over kinesthesis; The adjustment of motor behavior to displaced vision; Differences between displacements and other sources of variance; Performance under different visual feedback conditions; Differences between movement directions and the effect of training; Differences between directions of movement; Rule-learning versus specific learning; Task performance under visual displacement and the problem of abilities. TAB

N67-35468# Aerospace Medical Div. Aerospace Medical Research Labs. (6570th), Wright-Patterson AFB, Ohio.
CONTROL OF A REMOTE MANEUVERING UNIT DURING SATELLITE INSPECTION
Herbert J. Clark Mar. 1967 23 p refs
(AMRL-TR-66-134; AD-654327)

Operator performance in flying a simulated remote maneuvering unit (RMU) on a coplanar satellite inspection mission was evaluated under two conditions of RMU attitude control and two conditions of cockpit instrumentation. The maneuver was repeatedly performed successfully using either an on-off acceleration-command attitude control system or an on-off rate-command attitude control system, each with either a full panel of cockpit instruments (six) or only one cockpit instrument. The rate-command system was found to be superior for pitch control during station keeping and for roll control in general. The acceleration-command system was superior for pitch control during the trajectory portions of the mission. Because both control systems had disadvantages, consideration of a variable rate-control system is recommended. More economical and precise RMU control was obtained under the full-panel cockpit instrumentation condition irrespective of the control system used. The instruments of most value were found to be those which provided X (longitudinal) and Z (vertical) distance information. The limitations of the simulation and the advantages and disadvantages of an inside-out versus an outside-in television display of the target and its surrounds are also discussed. Author (TAB)

N67-35543# Air Force Academy, Colo. Frank J. Seiler Research Lab.
THE HUMAN EYE-MOVEMENT MECHANISM: EXPERIMENTS, MODELING AND MODEL TESTING Final Report Report
Gerald Cook and Lawrence Stark (Ill. Univ., Chicago) Jun. 1967 29 p refs
(SRL-67-0005; AD-654626)

A model for the human eye-positioning mechanism is presented. The derivation of the model is outlined briefly. Experiments for obtaining actual eye-movement behavior are described. Model simulations and comparisons of these results with experimental results are presented. The comparisons support the validity of the model. The physical basis of the model adds meaning to the model and insight into the operation of the actual system. Author (TAB)

N67-35550# School of Aerospace Medicine, Brooks AFB, Tex. Aerospace Medical Div.
AN EXPERIMENTAL ELECTRONIC STETHOSCOPE FOR AIRCRAFT USE Preliminary Report, 6 Jan.–23 Aug. 1966
Francis A. Brogan, Frederick G. Collins, and Morgan E. Wing May 1967 15 p ref
(SAM-TR-67-39; AD-655060)

An experimental electronic stethoscope for use aboard aeromedical evacuation flights and on flight lines was developed. Preliminary evaluation has indicated that such an instrument is both feasible and useful aboard aeromedical-evacuation aircraft and in patient staging areas on the flight line. Utilization of a noise-shielded pickup and earphones mounted in a noise-protection earmuff, plus the use of appropriate filter circuits, substantially excludes environmental noise while enhancing the audibility of desired sounds. Author (TAB)

N67-35585# Bunker-Ramo Corp., Canoga Park, Calif.
EFFECTS OF COCKPIT LIGHTING COLOR ON DARK ADAPTATION Final Report, Apr. 1966–Jan. 1967
Hugh A. Smith and Constance Goddard Wright-Patterson AFB, Ohio, AF Flight Dyn. Lab., May 1967 83 p refs
(Contract AF 33(615)-5225)
(AFFDL-TR-67-56; AD-654652)

The report is addressed to the general problem area of the effects of color of illumination on early dark adaptation. An analysis of the relevant published literature is presented as it relates to the relative benefits of red cockpit lighting as opposed to white or other colors for night flying. A report of a demonstration which compared the effects of green and white lighting to red lighting on subsequent early dark adaptation is included. An annotated bibliography of the literature reviewed for the report is also presented. A systems approach to cockpit illumination is stressed. Author (TAB)

N67-35603# George Washington Univ., Alexandria, Va. Human Resources Research Office.
WEBER'S LAW APPLIED TO DISTANCE ESTIMATION
R. E. Wienke Jun. 1967 11 p refs Presented at the Southwestern Psychological Assoc., Houston, Tex., Apr. 1967
(Contract DA-44-188-ARO-2)
(HUMRRO-PP-26-67; AD-654346)

The stimulus situation in dynamic range estimation is examined. The solid angle, taking into account the area of the target as well as the distance, is used as the visual concept, and the prediction made that range estimation would follow Webers Law. The results support the hypothesis that absolute errors in range estimation are an inverse function of the acceleration of the increase in size of the solid angle representing the target. The study suggests that one problem in research dealing with dynamic range estimation is that the results to be expected are highly dependent on the experimental conditions. Author (TAB)

N67-35643# American Inst. for Research, Washington, D. C.
STUDIES OF COMPONENT-TOTAL TASK RELATIONS: ORDER OF COMPONENT-TOTAL TASK PRACTICE AND TOTAL TASK PREDICTABILITY
Roy Omer Freedle, Albert Zavala, and Edwin A. Fleishman Mar. 1967 51 p refs
(Contract DA-49-193-MD-2632)
(AIR-E-29-3/67-TR-1; R67-4; TR-1; AD-654512)

The purpose of this study was to examine the relationships between performance on a complex (total) task and the performance on various components of that task when the latter are practiced in different orders. The total task (The Complex Coordinator) was represented as a composite of single-level and/or double-level task components. When the order in which the various tasks was ignored, 31.6% of the total task variance could be accounted for by the component task scores, but when order of practice was taken into account total task variance accounted for varied from 32.5% up to 70.6% depending on which particular double-level and single-level tasks were combined to predict total task scores. Thus order of practice on part tasks (component tasks) with respect to the total task makes a difference in predicting total task proficiency. More specifically, observed and predicted total task scores agree better when double-level components are practiced before the total task than when they are practiced after the total task. Also, total task proficiency is significantly improved by prior practice on double-level tasks. Prior practice on single-level tasks did not lead to significant total task improvement. Author (TAB)

N67-35674# Illinois Univ., Urbana. Group Effectiveness Research Lab.
A CONSIDERATION OF TWO ASSUMPTIONS UNDERLYING FEIDLER'S CONTINGENCY MODEL FOR THE PREDICTION OF LEADERSHIP EFFECTIVENESS
Martin Fishbein, Eva Landy, and Grace Hatch May 1967 32 p refs
(Contract Nonr-1834(36); ARPA Order 454)
(TR-52; AD-655102)

An attempt was made to explore two of the basic assumptions underlying Fiedlers (1964, 1965) Contingency Model: (1) the assumption that different group-task situations require a different leader-group member interaction, i.e., demand different types of leadership behaviors; and (2) the assumption that these demands will covary systematically with the three dimensions of the group-task situation specified by the Contingency Model. One hundred forty-one male undergraduates rated the way they believed the Most Effective Leader (MEL) should perform in each of eight group-task situations on a Behavioral Description Questionnaire. The results indicated that although these ratings of the MELs behavior did vary across the different group-task situations, the ratings were significantly influenced by only two of the three group-task dimensions isolated by Fiedler, namely, the leader-member relations and the position power dimensions. Additional hypotheses related to the Contingency Model were also investigated and discussed. Author (TAB)

N67-35684# Logistics Management Inst., Washington, D. C.
FORECAST OF AIRLINE PILOT REQUIREMENTS
May 1967 55 p refs
(Contract ARPA SD-271)
(AD-654182)

The report presents a forecast of pilot needs by the U.S. certificated route air carriers up to 1980. The forecast of active pilot employment was made in two ways: direct extrapolation of past employment trends; and estimates based on the forecast size and composition of the air carriers aircraft fleet. Forecasts of annual pilot attrition were included to arrive at annual estimates of new pilot demand. Since the long-range trend is of primary interest, short-term variations have not been highlighted. Based on the analyses qualifications detailed in the report, the most probable level of U. S. certificated route air carrier active pilot employment will be around 44,000 in 1977. The total number of new pilot hires during the next ten years is forecast to be around 31,000. TAB

N67-35742# George Washington Univ., Alexandria, Va. Human Resources Research Office.
HUMAN FACTORS RESEARCH IN SUPPORT OF ARMY AVIATION
Francis H. Thomas, Paul W. Caro, Jr., and Wiley R. Boyles Jun. 1967 21 p refs Presented at the 13th Ann. Symp. of the Southeastern Psychological Assoc., Atlanta, Apr. 1967 *Its* Profess. Paper No. 27-67
(Contract DA-44-188-ARO-2)
(AD-655126)

Three papers were presented as part of a symposium concerned with human factors implications in army aviation performance and training. The first paper deals with human factor problems in complex systems, particularly problems encountered in the aerial reconnaissance and surveillance subsystem of the combat intelligence system. The initial concern has been to improve human effectiveness in collecting battle area information through new training methods and techniques. the second paper deals with the effectiveness of the synthetic helicopter flight training devices and their usefulness for transfer of training from a rotary-wing instrument flight qualification course to performance on the actual helicopter. The third paper concerns research on aviator stresses during combat missions. The research objectives were to provide the army with readily usable information to variables that affect aviator performance, and to integrate this information into a system of performance prediction. Author (TAB)

N67-35768*# General American Transportation Corp., Niles, Ill. Research Div.
ADVANCED CONCEPT OF A LABORATORY-TYPE OXYGEN RECLAMATION SYSTEM FOR MANNED SPACECRAFT
A. J. Glueckert and G. A. Remus [1967] 81 p refs
(Contract NAS1-5289)
(NASA-CR-66403) CSCL 06K

Three processes comprising an oxygen reclamation system were investigated: electrolytic reduction of carbon dioxide in a molten carbonate electrolysis cell, oxygen permeation through a heated silver membrane, and catalytic disproportionation of carbon monoxide to carbon and carbon dioxide. The electrolysis cell effectively reduced carbon dioxide giving essentially theoretical yields of oxygen at the operating temperature of 1300°F. The electrolyte was a molten mixture of the carbonates of sodium, lithium and potassium immobilized by magnesium oxide to form a non-flowing matrix. Quantitative reduction of CO_2 could not be related to the power input due to cell body corrosion and electrolyte cross-leakage problems. These same problems prevented fabrication of a fully operational cell; due to a shift in emphasis to fabrication of the catalytic reactor, all of the research planned for this component was not completed. The catalytic reactor effectively disproportionated carbon monoxide to carbon dioxide and carbon. The most effective catalyst was H-219 nickel oxide. Conversion averaged 85% of theoretical with pure CO feed, and 52% with a 1:1 mixture of CO and CO_2. A one-tenth man capacity laboratory model was fabricated and operated continuously for eight days with the 1:1 CO and CO_2 feed mixture. Author

N67-35872*# Dunlap and Associates, Inc., Santa Monica, Calif.
HUMAN OPERATOR RESPONSE SPEED, FREQUENCY, AND FLEXIBILITY: A REVIEW, ANALYSIS AND DEVICE DEMONSTRATION
M. J. Wargo, C. R. Kelley, M. B. Mitchell, and D. J. Proisin Washington, NASA, Sep. 1967 80 p refs
(Contract NAS12-103)
(NASA-CR-874) CFSTI: HC $3.00/MF $0.65 CSCL 05H

A muscle action potential control, simultaneous visual-auditory display device was developed to demonstrate the increase in operator response speed, frequency and flexibility that can accrue from advanced manual control techniques. In a discrete control situation, muscle action potential control was found to increase response speed by approximately 100 ms and simultaneous visual-auditory display was found to reduce response time by an additional 40 ms. In a continuous control situation, muscle action potential control via the facial muscles increased operator response bandwidth across a range of forcing function amplitudes. Author

N67-35873# New York Research Group, Inc., N. Y.
A MATHEMATICAL MODEL FOR THE PERCEPTION OF TONES IN CONTEXT (II) Final Report, 16 May 1966–15 May 1967
David Rothenberg May 1967 51 p refs
(Contract AF 49(638)-1738)
(TR-II; AFOSR-67-1489; AD-655117)

A mathematical model was applied to the perception of stimuli which carry information, e.g. phonemes of spoken language, Morse Code signals, musical tones and rhythms. This report is restricted to that version of the model which applies to perception of tones in a musical context. (See also AD-647 270). The model described proposes a method by which a listener differentiates

and classifies the great number of different stimuli provided by music, such as musical intervals, durations, or timbres, using only a small number of learned classifiers. Such classifiers are orderings of stimuli and are extracted from the contexts in which the stimuli appear. It is postulated that these orderings rather than any fixed magnitudes are learned and remembered. Bounds on the structure of these classifiers and those distortions of perception which characterize the use of each are deduced. The relationship is developed between the structure of each of these classifiers and its potential usefulness in transmitting information. A Gestalt description of perception results in which extremely complex and varied phenomena can be perceived without proportionately large human memory. The decoding of information carried by stimuli within such Gestalt contexts is implicit in the model. Author (TAB)

N67-36016# Melbourne Univ., Parkville (Australia).
DYNAMICS OF A ROLE THEORY FOR THE WORKER'S JUDGEMENT
Richard C. S. Trahair Jul. 1967 46 p refs
(Contract Nonr-2296(02))
(TR-18; AD-654894)

Specific illustrations are presented to show that the worker seeks a degree of control over the physical demands and intrinsic satisfaction of task performance; authority, pay and security of positions; task competence and the mateship relation of persons. The extent to which the worker seeks control over additional benefits and promotion features of positions is limited by the kind of benefit under consideration, and the success ideology which characterize the lives of men at the lower levels of industrial administration. TAB

N67-36189# Grumman Aircraft Engineering Corp., Bethpage, N. Y. Research Dept.
MANUAL CONTROL SYSTEM ANALYSIS AND DESIGN USING A PARAMETER PLANE METHOD
S. Suh Aug. 1967 53 p refs
(RE-299)

An exact and useful graphic method for analyzing the stability of manual control systems including operator time delay is developed by using the parameter plane technique. This method can be applied to the analysis and design of nth order control systems with two adjustable parameters. The aim is to derive and formulate the basic equations in a way that will be easily understood and to show by examples how the method can be applied to manual control systems. Author

N67-36417# George Washington Univ., Alexandria, Va. Human Resources Research Office.
TRAINING RESEARCH UTILIZING MAN-COMPUTER INTERACTIONS: PROMISE AND REALITY
William A. McClelland Jun. 1967 19 p refs Presented at the Avionics Panel Program on Nat. and Artificial Logic Processors, AGARD, Athens, Jul. 1963 *Its* Profess. Paper 23-67
(Contract DA-44-188-ARO-2)
(AD-654818)

The paper was presented as part of the Avionics Panel Program on Natural and Artificial Logic Processors, sponsored by the Advisory Group for Aeronautical Research and Development, NATO. Several conceptual propositions in regard to man and the computer are offered. The nature of training research is examined. There is also a brief categorization of human behavior to suggest some of the uses and some of the difficulties in the utilization of computers in training research. The role of the training research psychologist dealing with large groups of people in mass instruction in a military setting is discussed, as is the importance of the computer for data processing and as a tool for simulating complex behavior. Author (TAB)

N67-36429# General Dynamics Corp., Groton, Conn. Electric Boat Div.
RESEARCH AND DEVELOPMENT OF A WASTE MANAGEMENT UNIT FOR A MANNED SPACE VEHICLE Technical Report, Dec. 1965–Dec. 1966
John Dodson and Harold Wallman Wright-Patterson AFB, Ohio, AMRL, Apr. 1967 27 p refs
(Contract AF 33(615)-3340)
(U-413-66-145; AMRL-TR-67-2; AD-654306)

A waste management unit (laboratory model) for use in a space simulator was designed, fabricated, and tested. The unit was designed to: Support 4 men for 30 days. Operate for five 30-day simulated missions. Operate under weightless or normal gravity conditions. Collect urine and feces separately but simultaneously while the user is in the seated position. Collect urine when the user is in the standing position. The unit incorporates a single sphere to collect, dehydrate, and store feces. This precludes the necessity of manual transfer of waste. Positive odor control is achieved with a forced air flow. Author (TAB)

N67-36491*# AiResearch Mfg. Co., Los Angeles, Calif.
STUDY OF ASTRONAUT CAPABILITIES TO PERFORM EXTRAVEHICULAR MAINTENANCE AND ASSEMBLY FUNCTIONS IN WEIGHTLESS CONDITIONS
E. C. Wortz, L. E. Browne, W. H. Shreck, A. J. Macek, W. G. Robertson et al Washington, NASA, Sep. 1967 431 p refs
(Contract NAS1-5875)
(NASA-CR-859) CFSTI: HC $3.00 CSCL 05H

Experiments were conducted on man's capabilities to perform manual work in the weightless environment. More than 200 experimental conditions were studied. The independent variables were simulation techniques, tasks, locomotion aids, restraint devices, and tools. This document describes the final results of both the analytical and experimental studies. Conclusions are drawn with respect to the effects of the independent variables, the human engineering observation, quantitative analyses, and physiological parameters. Hypotheses are advanced concerning the improvement of work in the weightless environment. Author

N67-36592*# Martin Co., Baltimore, Md. RIAS Div.
CHEMOSYNTHETIC GAS EXCHANGER Final Report, 8 Jun. 1964–14 Mar. 1967
Leonard Bongers and John C. Medici Apr. 1967 86 p refs
(Contract NASw-971)
(NASA-CR-88357; ER-13634-11) CFSTI: HC $3.00/MF $0.65 CSCL 06K

A chemosynthetic bioregenerative system for use in long-term space exploration is described that employs a functional coupling of electrolysis of water with biosynthesis by hydrogen bacteria. A considerable portion of man's metabolic wastes can be processed and recycled in this ecosystem; and presently available information indicates that the generation of hydrogen and oxygen by electrolysis is about 80% efficient. Both batch and continuous operations are discussed as cultivation procedures; and aspects of the chemical and physical environment considered are temperature, pH effects, inorganic nutrition, gas supply, and material balance in a closed environment. The efficiency of ATP formation and of carbon dioxide conversion is treated, along with the effect of oxygen on cytochromes. M.W.R.

N67-36614# Educational Testing Service, Princeton, N. J.
TRANSFER OF METAL ABILITIES AT DIFFERENT STAGES OF PRACTICE IN THE SOLUTION OF CONCEPT PROBLEMS
C. Victor Bunderson (Ph.D. Thesis Princeton Univ.) May 1967 113 p refs
(Contracts Nonr-1858(15); Nonr-2214(00); Grant NSF GB-3402)
(RB-67-20; AD-654202)

Theories of learning have typically failed to give an account of the role of human abilities, while accounts of mental abilities have not explained their relationship to learning in any rigorous way. The purpose of this study was to investigate the relationship of a set of factor-analytically derived ability measures to performance at different stages of practice in a learning set task employing concept problems, and to consider possible constructs to explain these relationships. Twenty-six problems, each of which required the identification of a four-dimensional conjunctive concept, were administered to a sample of 145 Princeton University undergraduates. To account for the complex learning involved in this task, a conceptual model involving information-processing constructs was developed. Three higher-order processes were postulated: a problem analysis process, which defined gaps between information available and information needed for solution; a search process, which looked among available responses for operators to reduce or to remove these gaps; and an organization process, which integrated operators thus found into a terminal program for solving the problems. A battery of 30 mental tests was administered to the same sample of students. The tests were selected as measures of factors chosen for their relevance to the model. The intercorrelations among the test scores were factor analyzed by a maximum-likelihood procedure. This procedure extracted factors in accordance with a simple-structure hypothesis set up in advance. A statistical test of this hypothesis showed it to be tenable. Author (TAB)

06 CHEMISTRY

Includes chemical analysis and identification (e.g., spectroscopy). For applications see: 17 Materials, Metallic; 18 Materials, Nonmetallic; and 27 Propellants.

N67-35340# Naval Research Lab., Washington, D. C.
A STUDY OF THE ADSORPTION OF CARBON-14 LABELED STEARIC ACID ON IRON
C. O. Timmons, R. L. Patterson, Jr., and L. B. Lockhart, Jr. 2 Jun. 1967 20 p refs
(ARPA Order 878)
(NRL-6553; AD-654567)

Stearic-1-C14 acid was adsorbed as a close-packed monomolecular layer on mechanically polished iron and fire-polished glass by the method of solution retraction. Measurements of the adsorbed radioactivity were made which allowed the determination of the number of adsorbed molecules per apparent unit area. Measurements of the methylene iodide contact angle on the two monolayer-covered surfaces showed that the surface packing density of stearic acid molecules was essentially the same in both cases. This conclusion, together with the assumption that the fire-polished glass surface had a roughness factor of unity, allowed the calculation of the area occupied per stearic acid molecule and of the roughness factor of the iron surface. The stearic acid molecule was found to occupy about 18.9 A2 on both iron and glass, and the roughness factor for the polished iron surface was 1.33. Desorption and exchange experiments indicated that about 60% of the monolayer on iron was rather weakly adsorbed and the remainder was probably chemically adsorbed. A rectilinear relationship was found between the measured contact angle and the extent of surface coverage. Additional studies of the temperature coefficients of the removal processes should permit determination of their activation energies and further clarification of the nature of the adsorption bond. Author (TAB)

N67-35342# Pennsalt Chemicals Corp., King of Prussia, Pa. Research and Development Dept.
ISOMER COUNTS FOR POLYNUCLEAR COORDINATION COMPOUNDS
Keith D. Maguire and Peter Block Jul. 1967 28 p refs
(Contract Nonr-2687(00))
(TR-54; AD-654705)

Application of symmetry concepts to a complete enumeration of all the possible permutations for a particular formulation is the basis for determining the expected number of isomers for polynuclear coordination compounds. Isomer counts are reported for several binuclear coordination compounds based on octahedral centers. Although compounds containing bidentate ligands cannot be handled in the symbolic system employed, isomer counts can be made for them by systematic elimination from an enumeration of all possible permutations. Author (TAB)

N67-35345* National Bureau of Standards, Washington, D. C.
A SURVEY OF THERMODYNAMIC PROPERTIES OF THE COMPOUNDS OF THE ELEMENTS CHNOPS Progress Report, 1 Apr.–30 Jun. 1967
George T. Armstrong, George T. Furukawa, and Martin L. Reilly 25 Aug. 1967 30 p refs
(NASA Order R-138)
(NASA-CR-87995; NBS-9607; Rept.-12) CSCL 07B

This report gives the details of the results obtained in the analysis of heat-capacity data on normal aliphatic hydrocarbons containing from 8 to 16 carbons and on tetraphosphorus decasulfide (P_4S_{10}). The sources of heat-capacity data for each of the substances are discussed and the interpretations of the experimental data are compared. The values of mean heat capacity for the temperature interval 0° to 50°C on the C_8 to C_{16} hydrocarbons, reported in 1902 by Mabery and Goldstein, were considered to be only of historical interest and were not given any weight in the analysis. The tables of thermodynamic properties obtained for the n-aliphatic hydrocarbons from C_8 to C_{16} and for P_4S_{10} are given at the end of this section. Author

N67-35373* Idaho State Univ., Pocatello. Dept. of Chemistry.
THE REACTIONS PERTAINING TO ZINC–SILVER AND CADMIUM–SILVER BATTERIES
G. Myron Arcand 21 Jun. 1967 8 p refs Revised
(Contracts NAS7-100; JPL-951887)
(NASA-CR-88011; QR-1) CSCL 07D

Preliminary results show that the insoluble product formed on the electro-oxidation of Zn in neutral KNO_3 is about 50% $Zn(OH)_2$. Heavily amalgamated Zn produces an anode which discharges at a reasonable rate. The Zn(Hg) electrode shows promise as a high-rate anode. High quality AgO has been produced electrochemically and approximate activation energies for thermal decomposition of AgO and AgO_2 have been determined. Author

N67-35377# Picatinny Arsenal, Dover, N. J. Plastics and Packaging Lab.
RADIATION GRAFT COPOLYMERIZATION
F. S. Holahan and D. W. Levi Jun. 1967 124 p refs
(PA-TR-3567; AD-654510)

The literature on radiation graft copolymerization is reviewed for the period between the late nineteen fifties and the middle of 1966. Included are descriptions of studies related to the various types of grafting reactions, the evaluation of factors important in grafting reactions, and properties of the grafted polymers. Author (TAB)

N67-35421 Joint Publications Research Service, Washington, D. C.
PROBLEMS IN CHEMICAL PHYSICS
22 May 1967 53 p ref Transl. into ENGLISH of the book "Problemy Khimicheskoy Fiziki" Moscow, Izv. Znaniye, 1967 p 2–30
(JPRS-41117; TT-67-31758) CFSTI: $3.00

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N67-35422 Joint Publications Research Service, Washington, D. C.
CERTAIN PROBLEMS OF QUANTUM CHEMISTRY
N. D. Sokolov *In its* Probl. in Chem. Phys. 22 May 1967 p 2–5 (See N67-35421 21-06)

The contributions and limitations of computer-assisted analysis in studies of molecular structures and properties are considered. The enormous value of rapid computer solutions to problems is acknowledged, but the continuing need for basic research work by theoretical physicists, mathematicians, and chemists is stressed. Several investigations in quantum chemistry are summarized to support the conclusions. E.C.

N67-35423 Joint Publications Research Service, Washington, D. C.
THE CHEMISTRY OF THE NEW ATOMS
V. P. Shantarovich *In its* Probl. in Chem. Phys. 22 May 1967 p 6–10 (See N67-35421 21-06)

Structure, size, and bonding energy of positronium and muonium are reviewed. Formation and chemical reactions of these atoms are compared and their potential for use in studying the velocities of hydrogen atom chemical reactions is considered. Muonium formation is discussed in terms of magnetic field theory, and positronium formation is discussed in relation to the appearance of positrons caused by the decay of sodium radioactive isotopes. E.C.

N67-35424 Joint Publications Research Service, Washington, D. C.
FREE RADICALS AND CHEMICAL LUMINESCENCE
V. Ya. Shlyapintokh *In its* Probl. in Chem. Phys. 22 May 1967 p 11–15 (See N67-35421 21-06)

Chemical luminescence properties and their applications in measuring the velocity of chemical processes are discussed. The significance of using photomultipliers to detect weak chemical luminescense is cited. The possibilities for controlling industrial chemical processes by observing increases in luminescent intensity resulting from reaction rate acceleration and formation of excited particles are considered. The complexities of investigating the kinetics of chemical reactions are discussed in relation to experiments involving oxidation by molecular oxygen. Comparative data on reaction mechanisms and chemical luminescence show that the glow resulting from oxidation reactions is connected with the interaction of two free radicals, the so-called peroxidic radicals. It was also established that the glow intensity characterizes quantitatively the concentration of the free radicals. Examples are included to show the application of chemical luminescent methods in measuring the concentration of free radicals and their reactions. E.C.

N67-35426 Joint Publications Research Service, Washington, D. C.
CHEMICAL REACTIONS IN SHOCK WAVES
P. Ya. Yampol'skiy *In its* Probl. in Chem. Phys. 22 May 1967 p 20–24 ref (See N67-35421 21-06)

Reactions of matter under high pressures, and achievements in high pressure physics and chemistry are mentioned. The technique of obtaining extremely high pressures with shock waves is cited. Use of these pressures in investigating chemical reactions is examined briefly. Attention is given to aspects of shock wave development resulting from the detonation of explosive substances. Shock wave applications in polymerization processes are also considered. E.C.

N67-35428# Aerospace Corp., El Segundo, Calif. Labs. Div.
PHOTOIONIZATION CROSS SECTIONS OF CALCIUM VAPOR, JULY–AUGUST 1966
Robert D. Hudson and Virginia L. Carter May 1967 17 p refs
(Contract AF 04(695)-1001)
(TR-1001(9260-01)-6; SSD-TR-67-96; AD-654286)

The atomic absorption cross section of calcium has been measured from 1750 to 2028 A at a bandwidth of 0.075 A using photoelectric techniques. Absolute cross sections are presented in four figures and compared with results obtained in other laboratories. Author (TAB)

N67-35437# Iowa State Univ. of Science and Technology, Ames.
KINETIC STUDIES OF THE OXIDATION OF TANTALUM CLUSTER IONS BY COBALT (III) COMPLEXES IN ACIDIC SOLUTION
Donald Joe Boone (M.S. Thesis) May 1967 36 p refs
(Contract W-7405-ENG-82)
(IS-T-165) CFSTI: HC $3.00/MF $0.65

The rates of reaction between the tantalum cluster ion $(Ta_6Cl_{12})^{2+}$ and various cobalt(III) complexes in acidic solution have been measured. For every complex studied, the stoichiometry was found to be consistent with one-electron oxidation of the tantalum cluster ion according to the equation $(Ta_6Cl_{12})^{2+} + Co(III) = (Ta_6Cl_{12})^{3+} + Co(II)$. The rate law in each case is second order $-d[(Ta_6Cl_{12})^{2+}]/dt = k\,[(Ta_6Cl_{12})^{2+}][Co(III)]$. Activation parameters were evaluated for the reaction between *cis*-chloroaquotetraamminecobalt(III) ion ($[Co(NH_3)_4(OH_2)Cl]^{2+}$) and $(Ta_6Cl_{12})^{2+}$. The fact that no chlorine-36 was found in $(Ta_6Cl_{12})^{3+}$ after oxidation of $(Ta_6Cl_{12})^{2+}$ with *cis*- $[Co(NH_3)_4(OH_2)^{36}Cl]^{2+}$ indicates an outer sphere path for electron transfer is most probable. Author (NSA)

N67-35442# Oak Ridge National Lab., Tenn.
ANALYSIS OF SOLUTION AND RADIOACTIVE SAMPLES BY SPARK SOURCE MASS SPECTROMETRY: [PART] II
J. A. Carter [1967] 7 p Presented at the MS-7 Users Meeting, White Plains, N. Y.
(Contract W-7405-ENG-26)
(ORNL-P-3051; CONF-670420-1) CFSTI: HC $3.00/MF $0.65

Experience in the use of spark source mass spectrometry for the analysis of radioactive materials is discussed. Analyses were made on Cr–Tc alloys for trace impurities and Tc concentration, uranium metal and uranium as the oxide, sulfide, phosphide, and nitride, Re–W thermocouple wires, radioactive solutions. Data are tabulated. NSA

N67-35443# Oak Ridge National Lab., Tenn.
ELECTROCHEMICAL MEASUREMENTS ON IODIDE BAR TITANIUM AT ELEVATED TEMPERATURES
H. S. Gadiyar 2 Jun. 1967 31 p refs
(Contract W-7405-ENG-26)
(ORNL-TM-1882) CFSTI: HC $3.00/MF $0.65

Electrochemical measurements on iodide bar titanium were made in oxygenated 0.05M K_2SO_4 and H_2SO_4 solutions at 240 and 257°C to obtain i–v characteristics, anodic film growth at constant potential, and in situ capacitance by pulse technique. Also included are ac impedance measurements made on these films at 25°C in different electrolytes. Author (NSA)

N67-35457# Iowa State Univ of Science and Technology, Ames.
HIGH TEMPERATURE CHEMISTRY OF HAFNIUM SULFIDES
Joseph Graham (M.S. Thesis) Feb. 1967 80 p refs
(Contract W-7405-ENG-82)
(IS-T-151) CFSTI: HC $3.00/MF $0.65

A systematic investigation was made of the solid phases in the hafnium–sulfur system. The solid phases Hf_2S and HfS were prepared and the structures determined by single crystal and powder X-ray diffraction. The bonding in these compounds is discussed, and symmetry, brittleness, electrical conductivity and Pauling bond numbers are correlated with the valence of the hafnium and sulfur atoms. In 1948 Rundle used delocalized, directional bonds of bond number 2/3 or 1/2 to describe the bonding in many transition metal-mono-carbides, -nitrides, and -oxides. This bonding description was extended to describe the bonding in Hf_2S and HfS and later to other MX and MX_{1-x} compounds where M is a IV B transition element and X is a V A or VI A element. The nonmetal atoms in these MX compounds are surrounded by a trigonal prism of metal atoms (in the TiP structure type by a trigonal prism or octahedron). It was suggested that the nonmetal atoms used d-orbitals to form bonding orbitals in this case. The valences of the nonmetal atoms in the sub-compounds MX_{1-x} are consistent with the use of s- and p-orbitals for the nitrides and oxides and d-orbitals with the other compounds discussed. In these compounds short metal–metal distances which may be non-bonding cause the calculated valences of the metal atoms to be unreasonably high. Author (NSA)

N67-35485# Arizona Univ., Tucson. Dept. of Chemistry.
THE INFLUENCE OF STRUCTURAL FACTORS IN THE THERMAL STABILITY OF METAL CHELATES OF 8-QUINOLINOLS Final Technical Report
David W. Kingston and Henry Freiser 6 Jul. 1967 14 p refs
(Contract Nonr-2173(08))
(AD-654735)

A systematic investigation was made of the effect of the metal ion on thermal properties of metal chelates of 8-quinolinol and some of its derivatives. The effect of substituents on the thermal decomposition temperatures of the metal chelates of these substituted ligands was also examined. TAB

N67-35493# Israel Program for Scientific Translations, Ltd., Jerusalem.
COPRECIPITATION AND ADSORPTION OF RADIOACTIVE ELEMENTS
V. M. Vdovenko, ed. 1967 281 p refs Transl. into ENGLISH of the book "Soosazhdenie i Adsorbtsiya Radioaktivnykh Elementov" Moscow, Izd. Nauka, 1965 Published for AEC and NSF
(AEC-TR-6716)

Articles on experimental and theoretical investigations of adsorption and coprecipitation processes and the distribution of a microimpurity between the solid and liquid phases are presented. For individual titles see N67-35494–N67-35524.

N67-35494# Israel Program for Scientific Translations, Ltd., Jerusalem.
INVESTIGATION OF THE TRANSFER OF MICROELEMENTS FROM THE LIQUID TO THE SOLID PHASE
I. V. Melikhov *In its* Coprecipitation and Adsorption of Radioact. Elem. 1967 p 1–24 refs (See N67-35493 21-06)

The general pattern of the transport of an impurity into the solid phase during the precipitation from a supersaturated solution is described. It is shown that the transport of the impurity involves several processes occurring either simultaneously or successively. These processes are interlinked in many ways and may pass through states involving a metastable equilibrium. Extremal coprecipitation conditions (liquid–kinetic, liquid–diffusion, adsorption–kinetic, and migration), under which the transport of the impurity into the precipitate is simplified, are also described. Experimental techniques of the study of extremal and of more complex cases of coprecipitation are discussed. Author

N67-35495# Israel Program for Scientific Translations, Ltd., Jerusalem.
THE COPRECIPITATION OF PLUTONIUM WITH LANTHANUM OXALATE, I
W. I. Grebenshchikova, R. V. Bryzgalova, and I. V. Chernitskaya *In its* Coprecipitation and Adsorption of Radioact. Elem. 1967 p 25–29 refs (See N67-35493 21-06)

It was found that at 50°C Pu is coprecipitated with lanthanum oxalate, forming anomalous mixed crystals with enrichment of the solid phase, but less than in precipitation at 20°C. The distribution of Pu(IV) between lanthanum oxalate and solution in isothermal supersaturation release followed the logarithmic law of Duerner and Hoskins. Increase of concentration of the oxalic acid in the solution caused a gradual decrease of the actual concentrations of Pu(IV) participating in the isomorphic exchange and therefore a decrease of the crystallization coefficient of Pu. It was established that for the system investigated $La(C_2O_4)_3 \cdot 8H_2O$–$Pu(C_2O_4)_2$–HNO_3–$H_2C_2O_4$ (HNO_3 is 1.5N) there is no linear relation between the crystallization coefficients and the proportion of solution components. Author (NSA)

N67-35496# Israel Program for Scientific Translations, Ltd., Jerusalem.
THE COPRECIPITATION OF PLUTONIUM WITH LANTHANUM OXALATE, II
V. I. Grebenschchikova, R. V. Bryzgalova, and I. V. Chernitskaya *In its* Coprecipitation and Adsorption of Radioact. Elem. 1967 p 30–33 refs (See N67-35493 21-06)

It was found that in mixed solutions of nitric acid and ammonium oxalate at 50°C plutonium forms anomalous mixed crystals with lanthanum oxalate. The absence of relation between the changes in the crystallization coefficients of Pu and the proportion of solution components was established. In the system given the basic factors determining the size of the crystallization coefficients seemed not to be the proportion of the solution components, but the change in the degree of complex formation by Pu(IV) in the solution. Author (NSA)

N67-35497# Israel Program for Scientific Translations, Ltd., Jerusalem.
COPRECIPITATION OF Ce WITH K_2SO_4 CRYSTALS. IV: EFFECT OF FOREIGN ADDITIVES ON THE COPRECIPITATION OF CERIUM
L. V. Melikhov, E. K. Krikova, and S. G. Babayan *In its* Coprecipitation and Adsorption of Radioact. Elem. 1967 p 33–42 refs (See N67-35493 21-06)

The presence of upper and lower limits of adsorption of Ponceau on the surface of stable crystals of K_2SO_4 was shown. The upper limits showed saturation of the crystal surface with oriented molecules of the dye. A sharp difference was found in the

adsorptive properties of stable and finely dispersed crystals of K_2SO_4. The relation of the lower limit of adsorption with precipitation of cerium with growing crystals of K_2SO_4 was determined.
Author (NSA)

N67-35498# Israel Program for Scientific Translations, Ltd., Jerusalem.
COPRECIPITATION OF Ce WITH K_2SO_4 CRYSTALS. VII: CAPTURE OF Ce BY K_2SO_4 CRYSTALS GROWING IN A NITRIC ACID SOLUTION
L. V. Melikhov, Z. Gerts, and S. G. Bayayan *In its* Coprecipitation and Adsorption of Radioact. Elem. 1967 p 43–52 refs (See N67-35493 21-06)

It was shown that the coprecipitation of Ce with K_2SO_4 during isothermal saturation of nitric acid solutions with K_2SO_4 occurs in three steps. In the first step the coefficient of capture of impurities in crystallizing masses of K_2SO_4 increases. In the second step it decreases. The character of the third step of co-precipitation was not established. The experimental data can be explained by the model according to which the diffusion of Ce into the solution affects the coprecipitation, rapid and slow adsorptive processes proceed on the surface of K_2SO_4, and acids change all surface processes and alter the conditions of impurities in solution, reducing their capacity to be adsorbed on the surface of solid phases.
Author (NSA)

N67-35499# Israel Program for Scientific Translations, Ltd., Jerusalem.
KINETIC METHOD FOR THE STUDY OF THE MECHANISM OF COPRECIPITATION AND THE PASSAGE OF Ce AND La INTO K_2SO_4 CRYSTALS
I. V. Melikhov *In its* Coprecipitation and Adsorption of Radioact. Elem. 1967 p 53–62 refs (See N67-35493 21-06)

The dependence of the distribution factors in coprecipitation on some coagulation of particles of the solid phase was studied. In the systems K_2SO_4–La and K_2SO_4–Ce it was shown that the method given makes it possible to analyze the complex process of coprecipitation into the elementary steps and reveals the possibility of investigating each stage independently of all others.
Author (NSA)

N67-35500# Israel Program for Scientific Translations, Ltd., Jerusalem.
EQUILIBRIUM DISTRIBUTIONS OF AN IMPURITY BETWEEN A SOLID AND A LIQUID PHASE. I: STATEMENT OF THE PROBLEM AND METHODS OF INVESTIGATION
I. V. Melikhov *In its* Coprecipitation and Adsorption of Radioact. Elem. p 62–69 refs (See N67-35493 21-06)

A discussion of the behavior of an impurity during recrystallization of finished crystals indicates that prolonged Ostwald ripening of the precipitate may produce an empirical equilibrium if the flow rates of the impurity from the solution to the precipitate and from the precipitate to the solution are exactly equal, if the crystals are fairly large, and if the changes in the crystal habit have ceased some time before the end of the rapid recrystallization. It is shown that the empirical and thermodynamic equilibria will coincide if the structure of the freshly deposited surface layers of the crystals is imperfect, and will correspond to a two-dimensional equilibrium if the freshly deposited layers have a perfect structure. A method is given for comparing the empirical and thermodynamic equilibria by studies of the impurity distribution within the cycle solid phase–H_2O–organic liquid–solid phase.
Author

N67-35501# Israel Program for Scientific Translations, Ltd., Jerusalem.
EQUILIBRIUM DISTRIBUTION OF AN IMPURITY BETWEEN A SOLID AND A LIQUID PHASE. II: STUDIES OF THE SYSTEM NaCl–CsCl–H_2O–ETHYLACETATE
I. V. Melikhov, E. V. Burlakova, and N. A. Merenkova *In its* Coprecipitation and Adsorption of Radioact. Elem. 1967 p 69–80 refs (See N67-35493 21-06)

The distribution of small amounts of Cs-137 between water and ethyl acetate, between ethyl acetate and a NaCl precipitate, and between a NaCl precipitate and water saturated with ethyl acetate at 25.0 ±0.1° were investigated. It is shown that when an empirical equilibrium is established, the Cs distribution coefficients in the systems NaCl precipitate–ethyl acetate and ethyl acetate–H_2O are independent of the volume of solution, the amount of precipitate, and the amount impurity. In the system NaCl precipitate–H_2O, the capacity of the solid phase to absorb the impurity decreases with increase in the amount of cesium in the solution. The experimental data indicate that the empirical and thermodynamic equilibria are identical at when the impurity concentration in the bulk of the crystals prior to washing is less than 2×10^{-3} m/g, and that they differ at a higher value.
N.E.N.

N67-35502# Israel Program for Scientific Translations, Ltd., Jerusalem.
EQUILIBRIUM DISTRIBUTION OF AN IMPURITY BETWEEN A SOLID AND A LIQUID PHASE. III: INVESTIGATION OF THE SYSTEM NaCl–AgCl–H_2O–ETHYL ACETATE BY THE METHOD OF CYCLES
I. V. Melikhov and E. V. Burlakova *In its* Coprecipitation and Adsorption of Radioact. Elem. 1967 p 80–86 refs (See N67-35493 21-06)

A study of NaCl–AgCl–H_2O–ethyl acetate system by the cycles method shows that in the AgCl concentration range studied, the distribution coefficients of the microcomponent between the precipitate and an aqueous solution saturated with ester, between the precipitate and an ethyl acetate solution saturated with H_2O, and between ethyl acetate and H_2O saturated with NaCl are independent of the impurity concentration, and of the amount of macrocomponent in the solution and precipitate. It was found that the experimental data agree with the given equation, which may be regarded as confirmation that the steady state established after prolonged recrystallization of a NaCl precipitate in a solution containing AgCl is identical with the thermodynamic equilibrium.
Author

N67-35503# Israel Program for Scientific Translations, Ltd., Jerusalem.
COPRECIPITATION OF ASTATINE WITH SOME SPARINGLY SOLUBLE PRECIPITATES OF MONOVALENT CATIONS
Fu-chiung Wang, N. G. Krylov, Yu. V. Norseev, Tao-nan Chao, and V. A. Khalkin *In its* Coprecipitation and Adsorption of Radioact. Elem. 1967 p 86–96 refs (See N67-35493 21-06)

Astatine, oxidized with bichromate and nitric acid solutions, co-precipitates with $Tl_2Cr_2O_7$, $Ag_2Cr_2O_7$, the phosphotungstate and phosphomolybdate of cesium, and $AgIO_3$. All the salts, except silver bichromate, adsorb astatine thoroughly from nitric acid solution. This property of the element confirmed previous conclusions on the existence in solutions of monovalent astatine cations.
Author (NSA)

N67-35504# Israel Program for Scientific Translations, Ltd., Jerusalem.
PURIFICATION OF URANYL NITRATE BY ZONE REFINING
Vikt. I. Spitsyn, A. N. Kirgintsev, E. G. Avvakumov, and I. M. Kuleshov *In its* Coprecipitation and Adsorption of Radioact. Elem. 1967 p 97–100 refs (See N67-35493 21-06)

Investigations of the distribution of $^{234}Th(UX_1)$ and the sum of the fission products between solid and liquid phases during directed crystallization of uranyl nitrate hexahydrate showed that the method of zonal recrystallization can be used for the purification of uranyl nitrate and for the concentration of radioactive impurities.
Author (NSA)

N67-35505# Israel Program for Scientific Translations, Ltd., Jerusalem.
INVESTIGATION OF THE SECONDARY ADSORPTION OF EUROPIUM ON $BaSO_4$. I: INFLUENCE OF THE COMMON ION OF THE PRECIPITATE. ADSORPTION ISOTHERM
V. A. Ishina, M. S. Frenklikh, and B. P. Nechaev *In its* Coprecipitation and Adsorption of Radioact. Elem. 1967 p 100–105 refs (See N67-35493 21-06)

The secondary adsorption of trace amounts of europium ($\approx 10^{-8}$M) on crystals of $BaSO_4$ for different excesses of SO^{2-} in solution was investigated. It was found that the dependence of the coefficient of adsorption on the percentage of SO^{2-} agrees with the Ratner equation. The equilibrium distribution of Eu between the precipitate and the saturated solution of $BaSO_4$ at $MSO^{2-} = 1.5 \times 10^{-4}$ and Eu concentrations in the interval from 10^{-6} to 10^{-8} M was investigated. It was found that the isotherm found obeys the Freundlich isotherm. Author (NSA)

N67-35506# Israel Program for Scientific Translations, Ltd., Jerusalem.
INVESTIGATION OF THE SECONDARY ADSORPTION OF EUROPIUM ON $BaSO_4$. II: EFFECT OF FOREIGN CATIONS
V. A. Ishina and M. S. Frenklikh *In its* Coprecipitation and Adsorption of Radioact. Elem. 1967 p 105–112 refs (See N67-35493 21-06)

The effect of cation impurities of different valencies and chemical natures on the adsorption of Eu on crystals of $BaSO_4$ was investigated. On the basis of the Ratner theory of secondary adsorption the equation of adsorption in the presence of competing ions of any valency was investigated. It was found that in the presence of Na^+, Mg^{2+}, and Al^{3+} desorption takes place in agreement with this theory, but the effects of La^{3+} and Th^{4+} on desorption seemed anomalously high. This was connected, apparently, with the low solubility of sulfuric acid salts of these elements in water. Author (NSA)

N67-35507# Israel Program for Scientific Translations, Ltd., Jerusalem.
INVESTIGATIONS OF THE CAPTURE MECHANISM OF La, Eu, and Sc BY IRON HYDROXIDE
V. I. Grebenshchikova and A. F. Prokudina *In its* Coprecipitation and Adsorption of Radioact. Elem. 1967 p 113–121 refs (See N67-35493 21-06)

The mechanism of the sorption of the trivalent elements, prone to hydrolysis, on precipitants of iron hydroxide was determined for different concentrations of hydrogen ions in solution. In the area of a high concentration of hydrogen ions, where maximum and irreversible sorptions were observed, the sorption mechanism apparently resulted from chemical interactions of hydroxide ions of the surface of molecules of colloidal $Fe(OH)_3$ with hydrolyzed ions of the type $R(OH)_2^+$. At low pH values, where irreversible sorption occurred, the exchange character of the sorption prevails, during which both R^{3+} and $R(OH)^{2+}$ ions can be exchanged with hydrogen ions of the hydroxide group $Fe(OH)_3$. Author (NSA)

N67-35508# Israel Program for Scientific Translations, Ltd., Jerusalem.
SORPTION OF MICROAMOUNTS OF HPO_4^{2-} IONS BY RADIOACTIVE AND IRRADIATED $BaSO_4$ PRECIPITATES
V. V. Gromov, F. Kepak, and Vikt. I. Spitsyn *In its* Coprecipitation and Adsorption of Radioact. Elem. 1967 p 122–125 refs (See N67-35493 21-06)

Investigations of the absorption of microquantities of HPO_4^{2-} from aqueous solutions of ^{35}S-labeled of $BaSO_4$ different specific activities as well as from solutions of non-active samples of $BaSO_4$, irradiated with high-energy electrons, indicated that in the cases given the microcomponents penetrate into the crystalline lattice of the $BaSO_4$. It was established that with increases in the dose of the absorbed β emission the extent of the sorption of the microimpurities decreases in the commercial preparations of $BaSO_4$. Author (NSA)

N67-35509# Israel Program for Scientific Translations, Ltd., Jerusalem.
DEVIATIONS FROM HENRY'S LAW IN RADIOCHEMICAL SORPTION SYSTEMS
Yu. V. Egorov *In its* Coprecipitation and Adsorption of Radioact. Elem. 1967 p 126–130 refs (See N67-35493 21-06)

The classification of the deviations from Henry's law in radiochemical sorption systems was investigated. Author (NSA)

N67-35510# Israel Program for Scientific Translations, Ltd., Jerusalem.
RADIOCOLLOIDS IN SORPTION SYSTEMS. I: SYSTEM WITH A VARIABLE MASS OF SORBENT
Yu. V. Egorov *In its* Coprecipitation and Adsorption of Radioact. Elem. 1967 p 130–136 refs (See N67-35493 21-06)

It was assumed that radioactive microcomponents in radiocolloidal condition represent a heterogeneous sorption agent, the absorption of which with solid collectors is accompanied by thermal effects, functionally combined with the extent of sorption. The sorption isotherm of such heterogeneous microcomponents was investigated for systems with different masses of the sorbent. Recommendations for the practical determination of the parameters of the suggested isotherm and verification of its accomplishment are given. The validity of the isotherm was confirmed in the case of the sorption of ^{144}Ce on vermiculite from a sodium nitrate solution. Author (NSA)

N67-35511# Israel Program for Scientific Translations, Ltd., Jerusalem.
SORPTION OF POLONIUM ON TEFLON
I. E. Starik and N. I. Ampelogova *In its* Coprecipitation and Adsorption of Radioact. Elem. 1967 p 136–141 refs (See N67-35493 21-06)

During the study of the sorption of Po from hydrochloric acid solution on fluoroplast-4, it was found that the magnitude of the sorption seems to be a function of the state of the Po in the solution and abruptly increases with the appearance in the solution of polonium hydroxy complexes. Chloride complexes of Po, as well as the nitrate and perchlorate complexes with fluoroplast-4 were sorbed insignificantly. The presence of neutral salts exerted a salting out effect on the sorption of Po as hydroxy complexes and reduced the sorption of chloride complexes of Po. The behavior of Po in sorption and extraction processes was determined by its state in the solution. Author (NSA)

N67-35512# Israel Program for Scientific Translations, Ltd., Jerusalem.
SORPTION OF RADIOACTIVE ELEMENTS FROM SOLUTIONS. II: SORPTION OF ^{110}Ag ON FLUORINATED GLASS (L-36) AND QUARTZ SURFACES
M. G. Rozovskaya *In its* Coprecipitation and Adsorption of Radioact. Elem. 1967 p 141–148 refs (See N67-35493 21-06)

It was established that during the interaction of hydrofluoric acid with the surface of these glasses substitution of the functional hydroxyl group with ions of the fluorine occurs. The magnitude of the adsorption on the fluorinated surface of the quartz glass did not exceed on the average 30% of the magnitude of the adsorption on non-modified surfaces. It was shown that the result of the interaction of the HF vapor and solutions of ammonium fluoride on L-36 glass depends on the state of the surface of the glass. The interaction of the HF vapor and NH_4F solutions on L-36 glass with a minimum possible surface layer led to reduced adsorptive properties of the glass. The effect of the concentrated (10 to

35%) HF solutions on L-36 glass did not depend on the state of its surface, which can be explained by the complete destruction of surface structure of the layer which leads, as was shown earlier, to reduced ion exchange properties of the glass. Author (NSA)

N67-35513# Israel Program for Scientific Translations, Ltd., Jerusalem.

INVESTIGATION OF THE FORMATION OF PROTACTINIUM COMPLEXES WITH CHLORIDE AND SULFATE IONS BY SORPTION ON SILICA GEL

A. V. Davydov and I. N. Marov *In its* Coprecipitation and Adsorption of Radioact. Elem. 1967 p 149–156 refs (See N67-35493 21-06)

It was found that in solutions with $[HNO_3] + [HCl] = 6\underline{M}$ at concentrations of HCl $<4\underline{M}$, two chloride complexes are formed of the types 1:1 and 1:2 with stability constants $\beta_1 = 0.025$ and $\beta_2 = 0.069$. It was established that in 3 and $6\underline{M}$ solutions of nitric acid, containing $1.5\underline{M}(NH_4)_2SO_4$, sulfate complexes are formed with the ratio $Pa:SO_4^{2-} = 1:1$ for which the value K_{f_1} equals 5.35 (for $3\underline{M}$ HNO_3) and 2.5 (for $6\underline{M}$ HNO_3). The mechanism of the sorption of protactinium on silica gel was considered. Author (NSA)

N67-35514# Israel Program for Scientific Translations, Ltd., Jerusalem.

ZIRCONIUM-BASED ION EXCHANGERS. III: ZIRCONYL ARSENATE

Yu. D. Sinochkin and D. A. Perumov *In its* Coprecipitation and Adsorption of Radioact. Elem. 1967 p 156–161 refs (See N67-35493 21-06)

A new zirconium-based ion exchanger was prepared. The zirconyl arsenate is stable over a wide range of pH, and selectively sorbs cesium from moderately acid media. Author

N67-35515# Israel Program for Scientific Translations, Ltd., Jerusalem.

THE ADSORPTION OF RADIOACTIVE ISOTOPES FROM MIXED SOLUTIONS

I. E. Starik, L. D. Sheidina, and F. L. Ginzburg *In its* Coprecipitation and Adsorption of Radioact. Elem. 1967 p 161–167 refs (See N67-35493 21-06)

Investigation of the sorption of Cs, Pu, and Pa on glass, fluoroplast-4, and metals from aqueous, water–alcohol, and water–acetone solutions showed that in $0.1\underline{N}$ HNO_3 the increase of the percentage of acetone in the solution of 90% did not exert noticeable influence on the sorption of Cs and Pu, but significantly increased the sorption of Pa. In less acid solutions the sorptive behavior of the elements investigated was complexly dependent on the concentration of the acetone and the nature of the sorbents. The sorption of Pu and Pa in water–alcohol solutions (0.1 to $0.01\underline{N}$ HNO_3) was of the same order of magnitude as in the sorption from aqueous solutions. Author (NSA)

N67-35516# Israel Program for Scientific Translations, Ltd., Jerusalem.

THE ADSORPTION OF GOLD FROM AQUEOUS SOLUTIONS ON GERMANIUM, SILICON, AND QUARTZ DURING WASHING

V. S. Sotnikov and A. S. Belanovskii *In its* Coprecipitation and Adsorption of Radioact. Elem. 1967 p 167–174 refs (See N67-35493 21-06)

An investigation of the adsorption of gold on germanium, silicon, and quartz from aqueous solutions showed that the adsorption of gold increases with increase in time of contact between the samples and the solution, and that at low concentrations it is proportional to the Au content in the solution, and obeys the Freundlich equation. Water at room temperature and boiling water cause only partial desorption of gold, which shows that the gold is strongly bound to the Ge, Si, and quartz surfaces. Gold is deposited on germanium in the metallic state and is absorbed on silicon mostly in the ionic state. It is absorbed on quartz solely in the ionic state, probably by a mechaniam which involves the displacement of H^+ ions from the OH-groups in the structure of the hydrated surface compounds on the silicon and quartz. Author

N67-35517# Israel Program for Scientific Translations, Ltd., Jerusalem.

THE ADSORPTION OF GOLD FROM H_2O_2, KOH, AND CP-8 DURING THE CHEMICAL ETCHING OF GERMANIUM, SILICON, AND QUARTZ

V. S. Sotnikov and A. S. Belanovskii *In its* Coprecipitation and Adsorption of Radioact. Elem. 1967 p 174–179 refs (See N67-35493 21-06)

The adsorption of gold was studied as a function of the concentration and time of contact between the samples and solutions. It is shown that there is a relationship between the values of the germanium and silicon potentials in the solutions and the degree of gold adsorption. Author

N67-35518# Israel Program for Scientific Translations, Ltd., Jerusalem.

SORPTION ISOTHERMS OF THE SULFATE COMPLEXES OF URANYL ON ANION-EXCHANGE RESINS OF VARIOUS BASICITIES

B. N. Laskorin and D. D. Slesareva *In its* Coprecipitation and Adsorption of Radioact. Elem. 1967 p 179–187 refs (See N67-35493 21-06)

The change in the sorptive capacity of anionites with changes in the equilibrium concentration of uranium in the solution in the range from 0.01 to $0.32\underline{M}$ (at constant concentration of the sulfate and solution pH) is well described by the Freundlich equation. The form of the uranyl sulfate complexes sorbed depends on the complete exchange capacity of the anionite and equilibrium concentration of uranium in the solution. Author (NSA)

N67-35519# Israel Program for Scientific Translations, Ltd., Jerusalem.

THE SORPTION OF URANIUM (VI) FROM HYDORFLUORIC ACID SOLUTIONS ON EDE-10P AND AN-2F WEAKLY BASIC ANION-EXCHANGE RESINS

V. S. Pakholkov and V. F. Stikhin *In its* Coprecipitation and Adsorption of Radioact. Elem. 1967 p 188–192 refs (See N67-35493 21-06)

The sorption of uranium from solutions of UO_2F_2–HF on the weakly basic anionites EDE–10P and AN–2F was investigated. It was established that both of the anionites investigated were characterized by the same behavior during sorption. By use of the anionites in the chlorine form, the quantitative extraction of uranium is possible only under the condition of the presence in the original solution of free acid: the molar ratio $UO_2^{2+}:F^-$ in it is probably 1:4. With anionites of the fluoride form uranium is sorbed from solutions of uranyl fluoride with any percentage of HF. The washing out of uranium from uranium-saturated EDE–10P and AN–2F was investigated with the solutions $1\underline{N}$ HNO_3, $0.9\underline{N}$ NH_4NO_3 + $0.1\underline{N}$ HNO_3, $1\underline{N}$ NH_4NO_3, and water. Author (NSA)

N67-35520# Israel Program for Scientific Translations, Ltd., Jerusalem.

THE SORPTION OF URANIUM (VI) ON THE STRONGLY BASIC AV-17 ANION-EXCHANGE RESIN FROM HYDROFLUORIC ACID SOLUTIONS

V. S. Pakholkov *In its* Coprecipitation and Adsorption of Radioact. Elem. 1967 p 192–198 refs (See N67-35493 21-06)

The sorption under dynamic conditions of uranium(VI) from UO_2F_2 solutions was investigated as a function of the concentration

of hydrofluoric acid using the anionite AV-17 in the chloride and fluoride form. The fact of the absorption of uranium(VI) above the exchange capacity of ionite was established. This was explained by the hydrolysis of the uranyl ions in the solution and in the ionite phase and by complex formation. The effect of the concentration of the uranium in the original solution on the sorptive capacities of the anionite was investigated. It was established that the sorptive capacity increased with increasing concentrations of uranium from 3.82 m$\underline{M}$ UO_2^{2+}/g for 0.0125$\underline{M}$ UO_2F_2 solution to 4.68 m$\underline{M}$ UO_2^{2+}/g for 0.0750$\underline{M}$ solution. From the analysis of the output curves of the sorption with the ionites in the chloride and fluoride forms, the conditions for the sorption of uranium without passage were confirmed and a sorption mechanism was proposed. Author (NSA)

N67-35521# Israel Program for Scientific Translations, Ltd., Jerusalem.

THE SORPTION OF URANIUM (VI) ON ANION-EXCHANGE RESINS FROM H_2SO_4–HF SOLUTIONS

V. S. Pakholkov *In its* Coprecipitation and Adsorption of Radioact. Elem. 1967 p 198–202 refs (See N67-35493 21-06)

The sorption of uranium(VI) from H_2SO_4 solutions on the anionites AB–17, EDE–10P, and AN–2F was investigated under dynamic conditions. It was established that the addition of hydrofluoric acid increased the sorptivity for uranium by 2 to 3 times in comparison with the sorptivity determined for pure sulfate solutions. The increase of the sorptivity with increase of the HF concentration was explained as the sorption of uranium principally in the form of monovalent fluoride complex anions, $UO_2F_3^-$. Author (NSA)

N67-35522# Israel Program for Scientific Translations, Ltd., Jerusalem.

THE SORPTION OF URANIUM(VI) FROM HCl–HF SOLUTIONS ON ANION-EXCHANGE RESINS

V. S. Pakholkov *In its* Coprecipitation and Adsorption of Radioact. Elem. 1967 p 203–209 refs (See N67-35493 21-06)

The sorption of uranium(VI) from HCl–HF solutions on the anionites AB–17, AV–16G, EDE–10P, and AN–2F was investigated under dynamic conditions. It was established that the addition of hydrofluoric acid to the hydrochloric acid uranyl solutions abruptly increased the sorptivity of the uranium because of the appearance in the solution of monocharged complex anions $UO_2F_3^-$. It was established that the uranium is not washed from the anionites with dilute solutions of chloride with the addition of HF. With respect to the capacity for regeneration, the anionites could be arranged in the following series: AV–17 > AV–16G > EDE–10P > AN–2F. Author (NSA)

N67-35523# Israel Program for Scientific Translations, Ltd., Jerusalem.

INVESTIGATION BY THE ION-EXCHANGE METHOD OF COMPLEX FORMATION BETWEEN TRIVALENT AMERICIUM AND THE ACETATE ION

I. A. Lebedev and G. N. Yakovlev *In its* Coprecipitation and Adsorption of Radioact. Elem. 1967 p 209–216 refs (See N67-35493 21-06)

The sorption of trace quantities of Am^{3+} on Dowex cationite 50×8 was investigated as a function of the concentration of acetate ions. It was established that, at acetate ion concentrations from 1.4×10^{-3} to 0.5$\underline{M}$ in solution, complex ions with the composition $AmAc^{2+}$ (Ac = acetate) and $Am(Ac)_2^+$ were present. The instability constants of americium acetate complexes at ion intensities of 0.2, 0.5, and 1.0 were calculated. By means of the extraction at zero ion intensity the thermodynamic instability constants for the ions $AmAc^{2+}$ and $Am(Ac)_2^+$ were calculated as 1.2×10^{-3} and 6.4×10^{-3}. Author (NSA)

N67-35524# Israel Program for Scientific Translations, Ltd., Jerusalem.

THE SORPTION OF CURIUM, LANTHANUM, ERBIUM, AND YTTERBIUM FROM LITHIUM CHLORIDE SOLUTIONS ON THE AV-17 ANION-EXCHANGE RESIN

V. A. Bochkarev and A. A. Lbov *In its* Coprecipitation and Adsorption of Radioact. Elem. 1967 p 216–222 refs (See N67-35493 21-06)

The distribution coefficients of La, Yb, and Cm between lithium chloride solutions and the anion exchange resin AV-17 were determined as a function of the LiCl and HCl concentrations and the temperature. The distribution coefficients of La, Er, Yb, and Cm from lithium chloride solutions, containing ethyl alcohol, were determined. An increase of the percentage of alcohol in the eluent to 15% significantly increased the distribution coefficient of Cm and only slightly affected the distribution coefficient of La. The optimum conditions for the separation of trace additions of Cm and Am were selected: concentration of lithium chloride 10$\underline{M}$, hydrochloric acid 0.1$\underline{M}$, ethyl alcohol ≈15 ml/100 ml solution, and temperature 60°C. For these conditions the distribution coefficient $D_d(Cm)/D_d(La)$ is 35. It was established that the resin AV-17 can be used for the successful separation of trace quantities of the transplutonium and rare earth elements. Author (NSA)

N67-35593 Nuklearni Institut Jozef Stefan, Ljubljana (Yugoslavia).

CONSISTENCY CRITERION FOR FERROELECTRIC FREE ENERGY CLUSTER EXPANSION

S. Svetina, R. Blinc, and B. Zeks Mar. 1967 6 p refs (NIJS-R-499)

The necessary condition that the cluster expansion as developed to determine the approximate free energy of hydrogen bonded ferroelectrics is thermodynamically consistent, is discussed, and the convergence of the series tested for the case of the KD_2PO_4 model Hamiltonian. Author

N67-35641# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

METHOD OF OBTAINING NITROALCOHOL CONTAINING FLUORINE [SPOSOB POLUCH NIYA FTORSODERZHASHCHIKH NITROSPIRTOV]

V. A. Komarov, A. V. Fokin, and K. V. Frosina 23 Feb. 1967 5 p Transl. into ENGLISH from Russian Patent no. 161717 (Appl. no. 812386/23-4, 7 Jan. 1963) 1 p (FTD-HT-66-624; AD-654644)

Fluorinated nitroalcohols are obtained by the condensation of difluonitromethane with aldehydes or ketones in the presence of catalytic amounts of potash at a temperature of 100 to 120C in the course of six hours. The yield of the product amounts to 50 to 90%. TAB

N67-35652# Joint Publications Research Service, Washington, D. C.

THE INDUSTRIAL MANUFACTURE OF HEAVY WATER

N. M. Zhavoronkov and K. K. Zakodynskiy 9 Aug. 1967 30 p refs Transl. into ENGLISH from Kernenergie (Dresden), v. 4, no. 12, 1961 p 893–904 (JPRS-42164; TT-67-32794) CFSTI: HC $3.00/MF $0.65

Some of the more important separation methods used in the manufacture of heavy water are discussed. These methods include electrolysis, chemical isotope exchange, electrolysis in combination with chemical exchange, dual temperature method of isotope exchange, and fractional distillation of water or hydrogen. Industrial plants around the world which manufacture heavy water are described and information is given on their methods, production, and costs. Several schematic drawings of the separation methods

used at these plants are shown. Plants in operation and in various stages of development are listed as well as cost data on the various heavy water processes. R.N.A.

N67-35661# Georgetown Univ., Washington, D. C. Dept. of Chemistry.
PROPERTIES AND STRUCTURES OF HETEROPOLY BLUES Final Report, 14 Nov. 1963–13 May 1967
Michael T. Pope 13 May 1967 13 p refs
(Grant DA-ARO(D)-31-124-G512)
(AROD-4598-5-C; AD-654767) CFSTI: HC $3.00

The work established that heteropoly blues are discrete anionic species, almost certainly isostructural with the oxidized anions. Heteropoly tungstates can be reduced in one-electron steps and the corresponding molybdates only in two-electron steps, a difference for which there is no immediately obvious explanation. Addition of electrons markedly affects the stability of the heteropoly structures, which become increasingly inert towards alkaline degradation upon reduction. Author (TAB)

N67-35671# IIT Research Inst., Chicago, Ill.
ADVANCED OXIDIZER CHEMISTRY Annual Summary Report, 1 Jan.–31 Dec. 1966
Irvine J. Solomon 21 Mar. 1967 57 p refs
(Contract AF 49(638)-1175)
(IITRI-C227-18; AFOSR-67-1521; AD-654730)

The structure of O2BF4 and the kinetics of decomposition of O2BF4 were studied. The structure was shown to be O2(+)BF4(-). The decomposition of O2BF is best explained in terms of an OOF radical. O17 and F19 NMR spectroscopy demonstrated that O3F3 does not exist as such, but is truly a mixture of O2F2 and O4F2. It was shown that both O2F2 and O4F2 are sources of the OOF radical and the use of O4F2 is the preferred route to OOF compounds. The reactions of O2F2 and O4F2 with nitrogen oxides produced some interesting results, but no new compounds were isolated. Some evidence for NO2OOF was obtained, but if this compound does exist, it readily decomposes to O2 and NO2F. Author (TAB)

N67-35680# Little (Arthur D.), Inc., Cambridge, Mass.
A LOW TEMPERATURE, HIGH PRESSURE HYDRATE OF n-TETRABUTYLAMMONIUM HALIDES
R. A. Horne and R. P. Young 14 Jul. 1967 6 p refs
(Contract Nonr-4424(00))
(TR-29; AD-654571) CFSTI: HC $3.00/MF $0.65

Aqueous 0.10M n-tetrabutylammonium chloride and bromide solutions solidify at high pressures at temperatures (+2 to +6C) well above the expected freezing point indicating the formation of stable high pressure hydrates. Author (TAB)

N67-35692# Aerospace Corp., El Segundo, Calif. Aerodynamic and Propulsion Research Lab.
THE DETERMINATION OF WATER IN NITROGEN TETROXIDE, NOVEMBER 1964–APRIL 1967
Frank D. Hess Jun. 1967 22 p refs
(Contract AF 04(695)-1001)
(TR-1001(2210-10)-6; SSD-TR-67-106; AD-655071)

A method is described for the analysis of water in nitrogen tetroxide based on the dielectric properties of these substances and their determination by oscillometry. Higher speed and greater accuracy can be obtained than with other methods. A detailed procedure is given. Author (TAB)

N67-35694# Controls for Radiation, Inc., Cambridge, Mass.
DETERMINATION OF CARBON, NITROGEN AND OXYGEN IN SILICON BY ACTIVATION ANALYSIS Interim Scientific Report
Gunter H. R. Kegel Apr. 1967 80 p refs
(Contract AF 19(628)-5980)
(AFCRL-67-0227; ISR-1; AD-654685)

Methods of determining impurities in silicon by activation analysis are reviewed. Impurities considered are carbon, nitrogen and oxygen with concentrations in the parts-per-million range. Non destructive techniques only are considered. Prompt reactions are unsuitable for these elements in the specified concentration range because the surfaces of the silicon samples will be contaminated by adsorption of impurities from the air. Reaction products should be sufficiently long lived to allow removal of adsorbed impurities between irradiation and measurement. Slow neutron and gamma irradiations lead to excessive matrix activation and therefore are not applicable. The same holds for irradiation with tritons obtained from the reaction Li6(n,alpha)t. Fast neutron activation yields reaction products with too short a mean life. The successful application of charged particle activation has been described in the literature; sensitivities below 1 ppm have been reported. These publications are reviewed. Methods for measuring positron activities in the presence of a gamma-ray background are described. A weighted least-squares-fit procedure for analysing composite decay curves is given. Author (TAB)

N67-35709# Washington Univ., Seattle. Dept. of Chemistry.
TRIPLET METHYLENE RADICAL REACTION WITH CIS-BUTENE-2
D. F. Ring and B. S. Rabinovitch 25 Jun. 1967 29 p refs
Submitted for publication
(Contract Nonr-477(36))
(TR-8; AD-654437) CFSTI: HC $3.00/MF $0.65

A study of the pressure dependence of the C5 products of the reaction between cis-butene-2 and triplet methylene radicals is reported. Triplet methylene was produced by collisional deactivation (in the presence of a large excess of nitrogen) of the methylene produced by the photolysis of diazomethane with 4358A radiation at 23C, and with unfiltered light at 23C and 56C. Reaction pressures were varied from 0.3 to 3.5 atmospheres; a constant ratio of cis-butene-2:diazomethane:nitrogen was maintained at 20:1:30,000. The observed pressure dependence of the product proportions indicates that alkene products arise in part by isomerization of the triplet dimethylcyclopropanes or diradicals, rather than exclusively by a concomitant, non-interceptible formation reaction. There is a pressure dependence of the ratio of trans-/cis-dimethylcyclopropane which, together with the pressure variability of products such as 3-methylbutene-1, dictates caution in the interpretation of the proportions of 3CH2/1CH2 from product proportions in photolysis systems. Author (TAB)

N67-35735*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
REACTION RATES OF CARBON MONOXIDE WITH HYDROXYL RADICALS AND OXYGEN ATOMS
Edgar L. Wong, Andrew E. Potter, Jr., and Frank E. Belles Washington, NASA, Sep. 1967 20 p refs
(NASA-TN-D-4162) CFSTI: HC $3.00/MF $0.65 CSCL 07D

A mass spectrometer stirred reactor technique was used to measure the rates of reaction of carbon monoxide with hydroxyl radicals and with oxygen atoms ($CO+OH \rightarrow CO_2+H$ and $CO+O+M \rightarrow CO_2+M$). For the $CO+OH \rightarrow CO_2+H$ reaction in the temperature range of 310° to 611°K, the rate constant based on CO_2 production was $4.2\pm0.8\times10^{11}\exp(-1200\pm300/RT)$ cubic centimeters per mole per second, where R is the gas constant and T is the absolute temperature. The rate near room temperature is lower than other values reported recently. The activation energy of 1200 calories per mole (500 J/mole) is in good agreement with recent estimates. For the $CO+O+M \rightarrow CO_2+M$ reaction, an upper limit value for its rate constant based on CO_2 production was estimated to be 4×10^{13} cubic centimeters squared per mole squared per second at 500°K. Since the CO+OH reaction is considerably faster

than the CO+O+M reaction, trace impurities giving rise to OH interfere with CO+O+M rate measurements, and may be responsible for the large differences in rate constants reported by various investigators for this reaction. Author

N67-35741# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
METHOD OF OBTAINING OZONE FROM MOIST AIR [SPOSOB POLUCHENIYA OZONA IZ VIAZHNOGO VOZDUKHA]
I. I. Stavnitser 23 Feb. 1967 5 p Transl. into ENGLISH from Russian Patent No. 169083 (Appl. No. 838266/23-26, 25 May 1963) 1 p
(FTD-HT-66-623; AD-654642)

An Author Certificate has been issued for a method of preparing ozone from humid air in an electric discharge between electrodes. In order to increase the ozone yield, the electrodes are continuously washed with a water-repellent dielectric. TAB

N67-35748# Washington Univ., Seattle. Dept. of Chemistry.
COMPETITIVE UNIMOLECULAR DECOMPOSITION OF CHEMICALLY ACTIVATED ALKYL RADICALS
C. W. Larson, B. S. Rabinovitch, and D. C. Tardy 25 Jun. 1967 69 p refs Submitted for publication
(Contract Nonr-477(36))
(TR-8A; AD-654436)

A study of competitive unimolecular decomposition of six chemically activated alkyl radicals is reported. Useful thermodynamic quantities associated with reactions of radicals were obtained. A quantum statistical treatment of the system on a Marcus-Rice basis gives excellent agreement with the data. Author (TAB)

N67-35765# Maryland Univ., College Park. Dept. of Chemistry.
TERTIARY PHOSPHINE COMPLEXES OF PLATINUM (II) AND PALLADIUM (II)
Richard L. Keiter (Ph.D. Thesis) Jun. 1967 121 p refs
(Grants AF-AFOSR-782-65; AF-AFOSR-782-67)
(AFOSR-67-1424; AD-654328)

The results are reported of research which was undertaken (1) to determine the chemical shifts of cis and trans isomers of platinum(II) complexes in hope of gaining information about pi-bonding in the Pt-P bond, and to extend this study to palladium(II); (2) to determine trends which may exist within a series of ligands for the purpose of developing expressions that would enable calculation of chemical shifts for complexes; (3) to expand the knowledge of the chemistry of tertiary phosphine complexes of platium(II) and palladium(II); and (4) to determine phosphorus coupling constants by preparing a complex of a chelating diphosphine (R2PCH2CH2PR2) or by preparing a complex containing two different phosphines. TAB

N67-35772# Idaho Univ., Moscow. Dept. of Chemistry.
REARRANGEMENT OF CARBONIUM IONS AND FREE RADICALS IN THE BICYCLO(3.1.0)HEXYL SYSTEM
Peter K. Freeman 13 Jul. 1967 13 p refs
(Grants AF-AFOSR-34-63; AF-AFOSR-875-65; AF-AFOSR-34-65)
(AFOSR-67-1552; AD-655139)

The objective of the research was the characterization of carbonium ion and free radical intermediates in the bicyclo (3.1.0)hexyl system and carbene intermediates in the bycylo (3.1.0)hexylidene system. Electrophilic additions of hydrogen chloride and the conjugate acid of methanol to bicyclo(3.1.0) hexene-2 demonstrate that the trishomocyclopropenyl carbonium ion is not a detectable product determining intermediate and that the addition reactions proceed via a 2-bicyclo(3.1.0)hexyl intermediate. Two bivalent intermediates were generated by sodium methoxide induced decomposition of the p-toluenesulfonylhydrozones of bicyclo(3.1.0)hexanone and 2-bicyclo(3.1.0)hexanone. Free radical addition of methanethiol to bicyclo(3.1.0)hexene-2 yields thiomethoxybicyclohexanes and thiomethoxymethylcyclopentenes. Free radical chlorination, using t-butyl hypochlorite, and chloroformylation, using oxalyl chloride, generate exclusively 2- and 3-bicyclo(3.1.0)hexyl radical intermediates, which behave in a completely analogous fashion to the thiomethoxy radicals generated in methanethiol addition. Author (TAB)

N67-35773# Tyco Labs., Inc., Waltham, Mass.
THE INVESTIGATION OF SILICON CARBIDE BY A TRAVELLING SOLVENT METHOD Final Report, Mar. 1, 1965–Jan. 31, 1967
Gunther A. Wolff and Badri N. Das Apr. 1967 77 p refs
(Contract AF 19(628)-4384)
(AFCRL-67-0271; AD-654305)

The crystallization of SiC from molten alloy mixtures of Cr-SiC, Cr5-Si3-SiC, and CrSi2-SiC of varying compositions was investigated. The resulting crystals were analyzed for their polytype structure and crystal morphology. Cubic (beta) SiC was obtained preferably from dilute solutions in molten Cr5Si3 when rapidly cooled. The amount of alpha-SiC increased for slower cooling rates; it was also greater for the other alloy mixtures. Structure identification was achieved by X-ray precession methods and by crystal morphology analysis. Etching in ClF3 gas at 400 C was used for the determination of polarity of SiC deposited from either molten alloy or from CH3SiCl3-H2 gaseous mixtures. This etch proved superior to previously used conventional etches in surface and dislocation studies. Epitaxial deposition was studied in detail with respect to substrate influence and structure propagation. Considerations on the crystal growth mechanism and on necessary requirements as dictated by morphology conditions are presented. It is stated that crystal growth and desired polytype formation can be well monitored by proper control of growth conditions as derived from morphology considerations, if it can be done at all. Author (TAB)

N67-35843# Brookhaven National Lab., Upton, N. Y.
GAMMA RADIATION INDUCED IONIC VINYL POLYMERIZATION
David S. Ballantine (AEC, Washington, D. C.) and Donald J. Metz [1966] 40 p refs Presented at the Polymer Sci., Current Concepts and Civic Appl. Conf., New York Sponsored by the AEC
(BNL-11344; CONF-670516-1) CFSTI: HC $3.00/MF $0.65

Experimental conditions for the radioinduced ionic polymerization of vinyl monomers, such as styrene, are described. Extreme measure to purify and dry the monomers and all glassware is stressed. Kinetics of the ionic polymerization are given. Molecular weight dependence on dose rate and nature of inhibitors are also discussed. NSA

N67-35850# Iowa State Univ. of Science and Technology, Ames.
DEFECT–DEFECT INTERACTIONS IN THE SILVER HALIDES WITH SPECIAL APPLICATION TO PURE SILVER CHLORIDE
Richard Anthony Sevenich (Ph.D. Thesis) May 1967 123 p refs
(Contract W-7405-ENG-82)
(IS-T-161) CFSTI: HC $3.00/MF $0.65

The defect concentrations in silver chloride were calculated self consistently for the temperature range 400°K to melting. This formalism was quite adequate for a Frenkel pair formation energy given by 1.48 to 10.4 kT. The agreement between the Lidiard thoery and this calculation was good below 620°K and above 620°K the Lidiard theory remained a first approximation. There were two striking results of the investigation. The first was the occurrence of a maximum in Δg, the change in the free energy of formation due to defect–defect interactions. It was shown that this maximum was to be expected in the case of the Lidiard theory. The second interesting result was that not all input parameters

are consistent with the equations of the theory. This fact was investigated for the simple case of the Debye–Huckel potential to find that there are a region of no roots to the equation for Δg, a region of two roots, and a point where there is one root separating the no-root and two-root regions. Author (NSA)

N67-35882# Iowa State Univ. of Science and Technology, Ames.
KINETICS OF THE VAPOR PHASE CHLORINATION OF NIOBIUM OXYTRICHLORIDE USING CARBONYL CHLORIDE
Dwight David Boesiger (Ph.D. Thesis) Feb. 1967 106 p refs
(Contract W-7405-ENG-82)
(IS-T-148) CFSTI: HC $3.00/MF $0.65

The kinetics of the reaction of niobium oxytrichloride with carbonyl chloride were investigated. The effects of time, temperature, and the concentrations of $NbOCl_3$ and $COCl_2$ on the rate of conversion of $NbOCl_3$ were studied in pyrex batch reactors. The range of total initial reactor pressures used was approximately 0.5 to 3.0 atmospheres. The major reaction products detected were niobium pentachloride and carbon dioxide. The method of nonlinear estimation of parameters was used to examine postulated kinetic models using variable temperature kinetic data. Author (NSA)

N67-35891# Naval Research Lab., Washington, D. C.
METHOD FOR ON-SITE DETERMINATION OF RESIDUAL ADSORPTIVE CAPACITY OF CHARCOALS USED IN CLOSED ENVIRONMENTAL SYSTEMS. PART 2: TEMPERATURE CHANGES DURING DESORPTION OF MOISTURE FROM CHARCOALS
D. L. Venezky and W. B. Moniz 21 Jun. 1967 19 p refs
(NRL-MEMO-1778, Pt. 2; AD-654905)

The relationship between the temperature decrease accompanying the desorption of water from adsorbent-type charcoals and their residual adsorptive capacity for organic compounds was studied. Investigation of fourteen charcoal samples from submarine main-carbon filters has shown that the time at which the minimum temperature of a charcoal sample undergoing water desorption is reached is proportional to its moisture content and correlates with the organic loading determined by steam desorption. The simple apparatus previously devised for determining the moisture content of a charcoal sample (NRL Memorandum Report 1710, August 31, 1966) was used to recirculate air in a closed-loop system, and transfer water from a charcoal sample to a desiccant. Temperature changes during the desorption process were conveniently displayed on a chart recorder which monitored a thermocouple located in a charcoal sample. Under conditions where the previously reported weight change procedure is not practical, the temperature change method is an alternative means for determining the residual adsorptive capacity of a charcoal. Author (TAB)

N67-35948# Technische Hochschule München (West Germany). Fakultaet fuer Allgemeine Wissenschaften.
CONCERNING 2- AND 3- PYRIDYL(4)-INDOLES [UEBER 2- UND 3- PYRIDYL(4)-INDOLE]
Sieghart Brodka (Ph.D. Thesis) 1967 100 p refs In GERMAN

Described is the synthesis of 3-pyridyl-indole and of indole derivatives by pyridine substitution in the 2- and 3- position. A Fischer indole synthesis, modified with nitrogen, was used to obtain α-amino alkylation and the transformation of N-acylpyridinium salts in the basic 2-pyridyl(4)-indole. The obtained α-pyridyl(4)-indole(3) aldehyde was easily methylated in nitrogen over the α-pyridyl(4)-tryptamine formation. Also described is the synthesis of 3-pyridyl(4)-indole through the reaction of indole with N-acylpyridinium salt and oxidation of the adduct. The reaction of indole-pyridine with trifluoro-acetanhydride resulted only in acylation. Transl. by G.G.

N67-35949# Technische Hochschule München (West Germany). Fakultaet fuer Allgemeine Wissenschaften.
ON LINKING AND REACTIVITY OF METHYL-METHOXYCARBENES IN TRANSITION METAL-CARBENE COMPLEXES [UEBER BINDUNG UND REAKTIVITAET DES METHYL-METHOXYCARBENS IN UEBERGANGSMETALL-CARBEN-KOMPLEXEN]
Rudolf Aumann (Ph.D. Thesis) 1967 55 p refs In GERMAN

Investigated was the reaction behavior of complex bound carbenes by using trimethyloxonium–tetrafluoroborate in aqueous phase at methylation medium. $(CO)_5CrC(OCH_3)CH_3$ and other carbene complexes reacted with $H_2N–N(CH_3)_2$ or $H_2N–NHC_6H_5$ by forming acetonitrile complexes, probably over the intermediary (hydrazino-, methylcarbene)-complex that immediately dissociated. The addition of $LiCH_3$ to monosubstituted metal hexacarbonyl formed a substituted carbene complex with the combination (ligand$(CO)_4$ metal(carbene). Only cis-oriented complexes were obtained in all investigated systems and it was concluded that the trans-effect of the ligand(methoxy-methylcarbene) was only very weak. Also reported is the complete characterization of $[HMn(CO)_4]$ which was accidentally obtained by introduction of anion bases in $CH_3Mn(CO)_5$. Transl. by G.G.

N67-35952# Technische Hochschule München (West Germany). Fakultaet fuer Allgemeine Wissenschaften.
PEPTIDES OF 3,3,3-TRIFLUORALANINES AND 3,3-DICHLOR-DEHYDRO ALANINES USING N-ACYL-TRIHALOGENATED ACETALDEHYDEAMINES AS REACTIVE INTERMEDIATE STAGES [PEPTIDE DES 3,3,3-TRIFLUORALANINS UND 3,3-DICHLOR-DEHYDROALANINS UNTER VERWENDUNG VON N-ACYL-TRIHALOGENACETALDIMINEN ALS REAKTIVEN ZWISCHENSTUFEN]
Reinhard S. Loy (Ph.D. Thesis) 1967 61 p refs In GERMAN

Reaction of N-acyl-trifluoracetaldimine with α-isocyano-carbolic acid-methyl-ester produced good quantities of 3,3,3-trifluoralanine in peptides. Elimination of 1 Mol HCl during cyclination to 2-oxazole-derivative produced 2,2-dichlor-dehydroalanine-peptide. Grignard reactions with N-benzoic-trichloracetaldimine resulted only in traces of the corresponding α-amino acids. Alkyl substituted malonic esters were obtained by photolysis of the diazo-malonic ester in hydrocarbons. Transl. by G.G.

N67-35953# Technische Hochschule München (West Germany). Fakultaet fuer Allgemeine Wissenschaften.
ABSORPTION SPECTROSCOPIC INVESTIGATIONS ON SINGLE CRYSTALS OF SOME ACENES, ACRIDENES, AND PHENAZINES [ABSORPTIONSSPEKTROSKOPISCHE UNTERSUCHUNGEN AN EINKRISTALLEN EINIGER ACENE, ACRIDINE UND PHENAZINE]
Peter O. Dreyer (Ph.D. Thesis) 1967 22 p refs In GERMAN

Combined spectrophotometer and interference microscopic measurements are reported on single crystal absorption spectra in organic compounds. The position of the oscillating crystal is determined by addition and evaluation of the molecular vector oscillations. Included is a table that shows spectra, splitting patterns, phase shifts, and intensity relations for the following substances: anthracene, tetracene, pentacene, acridine, and benzoic acridine and phenazine solutions. Transl. by G.G.

N67-35974# Technische Hochschule München (West Germany). Fakultaet fuer Allgemeine Wissenschaften.
MODEL PRESENTATIONS OF THE MOLECULAR CHEMISTRY OF THE 19th CENTURY [MODELLVORSTELLUNGE DER MOLEKULARCHEMIE DES 19. JAHRHUNDERTS]
Waldburg Eder (Ph.D. Thesis) 1966 197 p refs In GERMAN

Reviewed are the various theoretical models for molecular chemistry from the 6th century through the 19th century. Special emphasis is placed on Dalton's work with gas atoms, Berzelius'

theory on the influence of electricity on molecules, the nucleus theory, Pasteur's recognition of asymmetric and symmetric ordered atoms, tautomery, valence structures, etc. Later developed electron theories cover electrochemical properties of molecules in organic compounds. Transl. by G.G.

N67-35975# Technische Hochschule München (West Germany). Fakultaet fuer Allgemeine Wissenschaften.
QUANTITATIVE INVESTIGATIONS ON STABLE BLUE SOLUTIONS OF SULPHUR IN ORGANIC SOLVENTS [QUANTITATIVE UNTERSUCHUNGEN AN STABILEN BLAUEN LOESUNGEN DES SCHWEFELS IN ORGANISCHEN LOESUNGSMITTELN]
Siegfried Benninger (Ph.D. Thesis) 1967 65 p refs In GERMAN
CFSTI: HC$3.00/MF$0.65

The three pronounced extinction maxima in the absorption spectrum of sodium sulfite and sulfur in dimethyl formamide solution were studied for their extinction characteristics. The peak at 16.2 kK produced the intensively blue color of the solution and was attributed to a neutral sulfur component in equilibrium state. The extinction in the 31 to 34 kK range corresponded exactly to the amount of used sodium sulfide. Extinction measurements between +70°C and −60°C showed that the above-named maxima change in alkali polysulfides when cooled to below −20°. Electron spin resonance measurements did not give any results for diluted solutions. Transl. by G.G.

N67-35982*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
ELECTROCHEMICAL REDUCTION OF CHLORINE ON CARBON IN MOLTEN LITHIUM CHLORIDE–POTASSIUM CHLORIDE
Andrew E. Potter and Betty S. Del Duca Washington, NASA, Sep. 1967 20 p refs
(NASA-TN-D-4175) CFSTI: HC$3.00/MF$0.65 CSCL 07D

Chronocoulometry was used to study the reduction of chlorine on pyrolytic graphite in molten lithium chloride–potassium chloride from 410° to 500°C. The amount of chlorine adsorbed on pyrolytic graphite in the molten salt at 1 atmosphere chlorine pressure was found to be approximately 1×10^{-11} equivalents per square centimeter. The reduction of chlorine was diffusion-limited for overvoltages larger than 56 millivolts, and the average diffusion coefficient was 0.3×10^{-5} square centimeter per second, assuming a chlorine solubility of 1×10^{-5} moles per cubic centimeters. Double-layer capacitances for the pyrolytic graphite ranged from 48 to 62 microfarads per square centimeter. Activated charcoal electrodes were also studied. The amount of chlorine adsorbed by the activated charcoal was found by coulometry to be about 3×10^{-5} equivalents per gram, or about 3×10^{-11} equivalents per square centimeter, similar to graphite. Author

N67-36096# Technische Univ., Berlin (West Germany). Lehrstuhl fuer Strahlenchemie.
DEGREDATION AND BRANCHING OF POLYVINYL ACETATE IN SOLUTION UNDER THE INFLUENCE OF ^{60}Co–γ-IRRADIATION [ABBAU UND VERZWEIGUNG VON POLYVINYLACETAT IN LOESUNG UNTER DER EINQIRKUNG VON ^{60}Co–γ-STRAHLEN]
E. Schamberg Mar. 1967 14 p refs In GERMAN; ENGLISH summary
(BMWF-FBK-67-24)

Linear polyvinyl acetate possessing an approximately random molecular weight distribution was γ irradiated in acetone solution at various concentrations. By light scattering and viscosity measurements it was found that at concentrations below the critical concentration for gel formation the polymer is crosslinked to a certain extent besides the predominant degradation of the main chain. In accordance with the previously developed theory of simultaneous crosslinking and degradation the ratio of the specific degradation and crosslinking densities p_0/q_0 was increased with decreasing polymer concentration and surpassed the value 2 at the critical concentration. Author (NSA)

N67-36103# Bureau of Mines, Amarillo, Tex.
A METHOD FOR TREATING PVT DATA FROM A BURNETT COMPRESSIBILITY APPARATUS
Robert E. Barieau and B. J. Dalton Sep. 1967 41 p refs
(RI-7020)

A method is described for treating pressure-volume-temperature data obtained with a Burnett compressibility apparatus. The method makes use of a general nonlinear least-squares technique. It is assumed that an adequate functional form is available for the expression of the compressibility factor as a function of either the molal density or the pressure. The functional form of the compressibility factor can be either linear or nonlinear in the parameters to be evaluated. Formulas are given for calculating variances and covariances of all parameters evaluated and for calculating the variance of calculated quantities of interest. Author

N67-36149# Technische Hochschule Munchen (West Germany). Fakultaet fuer Allgemeine Wissenschaften.
NUCLEAR SPIN MEASUREMENTS ON SOLUTIONS OF SODIUM IN AMMONIA [KERNSPIN-ECHO-MESSUNGEN AN LOESUNGEN VON NATRIUM IN AMMONIAK]
Peter Hauser (Ph.D. Thesis) 1966 30 p refs In GERMAN

The longitudinal and transversal proton spin relaxation times T_1 and T_2 of sodium–ammonia solutions were measured by the nuclear spin resonance method. Measurements were made within the concentration range from 10^{-3} to 2.10^{-2} mole Na/mole NH_3, at temperatures between +20°C and −78°C, and at resonance frequencies of 48 MHz and 14 MHz. The paramagnetic portion of the dissolved sodium lowered the proton spin relaxation times T_1 and T_2 when compared with pure ammonia. The lowering of T_1 was mainly due to the magnetic dipole change effect, that of T_2 was mainly due to scalar coupling between the solvatized electrons and the ammonia protons. The diffusion coefficient D was measured concurrently with T_2. For pure ammonia, D is identical with the self-diffusion constant of the ammonia; for sodium–ammonia solutions, it is identical with the proton spin diffusion constant D_s. Transl. by K.W.

N67-36157 Joint Publications Research Service, Washington, D. C.
DETERMINATION OF ELASTICITY AND SHAPE OF MACROMOLECULES
V. N. Tsvetkov 1 Sep. 1967 28 p refs Transl. into ENGLISH from Zh. Vses. Khim. Obshch (USSR), v. 6, 1961 p 426–434
(JPRS-42388; TT-67-33017) CFSTI: HC$3.00

Several experimental techniques used to investigate macromolecule elasticity in polymer structures are reviewed. A differentiation is made between the equilibrium (thermodynamic) and kinetic (nonequilibrium) elasticity of the polymeric chain, and it is pointed out that greater experimental and theoretical possibilities exist for determining the equilibrium elasticity. The discussion covers the quantitative evaluation of equilibrium elasticity of a molecular chain, the influence of the surrounding media (solvent) on the macromolecule configuration, methods for determining macromolecule sizes, dimensions of linear macromolecules in solutions, and the elasticity of chain and shape of the molecular coil. In considering the elasticity, structure, and optical anisotropy of the molecular chain, the examples given show that optical anisotropy of molecular chains is very sensitive to changes in their elasticity and structure. For evaluating the kinetic elasticity of chains, the methods mentioned consist of a study of the hydrodynamic behavior of macromolecules in a solution subjected to periodic shear stresses. A reference bibliography is included. M.G.J.

N67-36288* Scientific Translation Service, La Canada, Calif.
MECHANISM OF VAPOR PHASE REACTIONS OF ALKANES WITH NO_2. KINETICS AND CHEMISTRY OF SLOW REACTION OF C_3H_8 WITH NO_2 [MEKHANIZM PAROFAZNOGO VZAIMODEYSTVIYA ALKANOV S DVUOKIS'YU AZOTA. KINETIKA I KHIMICHESKIYE OSOBENNOSTI MEDLENNOY REAKTSII C_3H_8 SNO_2]
A. P. Ballod, S. I. Molchanova, and V. Ya. Shtern. Washington, NASA, Jul. 1967. 11 p refs. Transl. into ENGLISH from Neftekhim., v. 7, no. 1, 1967 p 115–123
(Contract NASw-1496)
(NASA-TT-F-11115) CSCL 07C

The slow reaction between propane and nitrogen was investigated in a vacuum. The intermediate products and end products of the reaction were identified, and the nitration energy of propane was determined. Author

N67-36294# Oak Ridge National Lab., Tenn.
ELECTROCHEMICAL MEASUREMENTS ON NIOBIUM AT ELEVATED TEMPERATURES
H. S. Gadiyar, A. L. Bacarella, and A. L. Sutton. 2 Jun. 1967. 16 p refs
(Contract W-7405-ENG-26)
(ORNL-TM-1883) CFSTI: HC $3.00/MF $0.65

Preliminary studies on the electrochemistry of film formation on chemically polished Nb at 200°C are reported. During film formation in 0.05 M K_2SO_4 at 200°C, the rate steadily decreased first up to about 100 min and then became somewhat steady, changing from 1.0×10^{-8} to 5.5×10^{-7} amp/cm^2 from 110 to 5,600 min. It was found that film growth does not follow logarithmic, cubic, or hyperbolic sine function relations. The results indicated the formation of a porous film or film dissolution. Corrosion rates (at anodic potential +0.1 V) in 0.05 M H_2SO_4 decreased to about 3.2×10^{-8} amp/cm^2 after about 60 to 70 min exposure at 200°C, remained steady in the region for sometime up to around 300 min, and then again increased to values of 1×10^{-5} amp/cm^2 at 900 to 1000 min exposure. NSA

N67-36295# Oak Ridge National Lab., Tenn.
UO_2–ThO_2 AND UO_3–ThO_2 SOLS PREPARED BY PRECIPITATION–PEPTIZATION PROCESSES
A. B. Meservey. 20 Mar. 1967. 20 p refs
(Contract W-7405-ENG-26)
(ORNL-TM-1782) CFSTI: HC $3.00/MF $0.65

Coprecipitation methods were used for the preparation of mixed thoria–urania sols, as possible alternates to solvent extraction methods. Exceptionally stable sols (>18 mo.) resulted from the coprecipitation of Th and U(IV) hydroxides in Th/U ratios of 1/1 and 3.5/1. Satisfactory microspheres were formed and calcined from one of these sols. A new coprecipitation method was developed for preparing 3 Th/1 U mole ratio sols using hexavalent U, featuring the attainment of low nitrate-to-metal ratios by a seed sol technique. The sols readily formed noncracking microspheres in 2-ethyl-1-hexanol by the conventional ORNL method and were fired to 99.5% of theoretical density and less than 1% porosity. Author (NSA)

N67-36298# MSA Research Corp., Evans City, Pa.
DEVELOPMENT OF TECHNIQUES FOR THE MEASUREMENT OF IMPURITIES IN SODIUM. Quarterly Progress Report, Jan.–Mar. 1967
May 1967. 16 p refs
(Contract AT(11-1)-765)
(MSAR-67-80) CFSTI: HC $3.00/MF $0.65

Developments in the surface tension method for determining impurities in sodium are described. Various design aspects of a new surface tension apparatus are illustrated. The new apparatus will permit precise sodium surface tension measurements under various oxygen concentrations. NSA

N67-36303# Oak Ridge National Lab., Tenn.
SIXTH RARE EARTH RESEARCH CONFERENCE
[1967] 746 p refs. Proc. of the Conf. held in Gatlinburg, Tenn., 3–5 May 1967
(Contracts AF AFOSR-67-0001; AF AFOSR-67-0226)
(AFOSR-67-1214; AD-653605)

This report contains preprints of papers presented at the technical sessions of the Sixth Rare Earth Research Conference held at Gatlinburg, Tennessee, May 3-5, 1967. The sessions were divided into chemistry, solid state, metallurgy, and industrial processes. TAB

N67-36304# American Potash and Chemical Corp., New York. Market Development and Technical Services.
RARE EARTH USES
Howard E. Kremers *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 1–6 (See N67-36303 21-06)

The development of rare earth uses and industrial processes is covered in an historical presentation beginning with the 1890's when crude neodymium and praseodymium concentrate were first used in glass coloring. It is noted that, except for cerium, the only rare earth materials available from industry for many years were in the form of mixtures, and that the American rare-earth producing industry did not really develop until the World War I allied blockade cut off supplies of German thorium nitrate. Various present-day efforts are noted, including commercial ion exchange separation of rare earths that began in the mid-1950's. The capacity to convert rare earth ore to rare earth products increased in the United States from about 1,000 tons per year in the 1920's to 14,000 tons rare earth oxide equivalent in the 1960's. M.W.R.

N67-36317# Oxford Univ. (England).
NON-STOICHIOMETRY AND CRYSTAL DEFECTS IN THE SOLID STATE CHEMISTRY OF THE LANTHANIDES
J. S. Anderson *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 112–131 refs (See N67-36303 21-06)

Three classes of largely ionic lanthanide compounds are considered that display nonstoichiometric phenomena. Since the nitrides come into that group of phases with such a high defect concentration, a completely random model is considered unacceptable. In the oxides and chalcogenides, however, there are indications of strong tendencies of strict local ordering. A survey is made to determine the real constitution of grossly nonstoichiometric phases and the structural principles that must be postulated to account for such phases. Conditions under which stoichiometric variability is observed are also considered in this survey that deals with crystal defects in the solid state chemistry of lanthanides. M.W.R.

N67-36318# Kennecott Copper Corp., Lexington, Mass. Ledgemont Lab.
POINT DEFECTS IN SOME RARE EARTH DIHYRIDES
G. G. Libowitz and J. B. Lightstone *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 132–144 refs (See N67-36303 21-06)

By comparing experimental data for lanthanum, cerium, and gadolinium dihydrides with previously derived thermodynamic expressions relating chemical activities with deviations from stoichiometry, the defects responsible for the non-stoichiometry in these compounds may be identified. It is shown that the predominant defects in the stoichiometric rare earth dihydrides are Frenkel defects, with excess hydrogen interstitials causing positive deviations from stoichiometry and excess hydrogen vancancies causing negative deviations from stoichiometry. Intrinsic defect concentrations ranged from 2 to 5% over the temperature range 300 to 800°C. The vibrational entropy change for Frenkel defect formation was found to be negative and to contribute at least as much to the free energy of defect formation as does the enthalpy term. Author

N67-36319# Texas Univ., Austin. Dept. of Chemical Engineering.
THE CRYSTAL CHEMISTRY OF SELECTED AB_2 RARE EARTH COMPOUNDS WITH Se, Te, AND Sb
R. Wang and H. Steinfink *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 145–154 refs (See N67-36303 21-06)
(Grant AF-AFOSR-806-65)

A structural investigation is made of the stoichiometry of REB_2, where RE is a rare earth element and B an element of groups V or VI. Single crystal X-ray diffraction techniques were used to determine crystal structures and resolve data based only on powder diffraction diagrams. Well formed single crystals could be found for Dy, Er, Gd, Ho, and Sm diselenides; and their patterns were essentially identical. The small Ce, La, and Nd diselenide crystals produced were not suitable for single crystal techniques. Crystallographic data for all the diselenides are tabulated, and a refinement of the structure of $ErSe_2$ is reported. Lattice parameters for Ce, La, Nd, and Sm antimonide crystals are also tabulated, as are final atomic parameters and interatomic distances and their standard deviations for $SmSb_2$. M.W.R.

N67-36320# Massachusetts Inst. of Tech., Cambridge. Dept. of Metallurgy.
CRYSTAL CHEMISTRY OF Au-RICH ALLOY PHASES WITH THE HEAVY RARE EARTHS
V. Sadagopan, B. C. Giessen, and N. J. Grant *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 155 (See N67-36303 21-06)

Using X-ray powder diffractometry, a comparative study was made of the binary alloy phases formed by Au with the rare earth metals Nd, Sm, Gd, Dy, Ho, Er, and Yb, as well as with Y, covering the concentration range between (R.E.)Au_2 and Au. The (R.E.)Au_2 phases of the $MoSi_2$–$C11_b$ type were found to exist from $GdAu_2$ to $YbAu_2$; while (R.E.)Au_3 phases of the distorted $TiCu_3$–DO_a type exist from $GdAu_3$ to $YbAu_3$ with strongly changing axial ratios. The (R.E.)Au_4 phases, probably with the $MoNi_4$–$D1_a$ type, exist for $ErAu_4$ and $YbAu_4$. The atomic coordination relationships of all these phases are discussed, and Y can be shown to act like a rare earth which is located between Ho and Er; Dy is found to behave like a trivalent rare earth in these alloy phases. Author

N67-36321# Argonne National Lab., Ill. Metallurgy Div.
TERNARY COMPOUNDS HAVING THE $CeCu_2$-TYPE STRUCTURE
A. E. Dwight *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 156–165 refs Sponsored by AEC (See N67-36303 21-06)

The occurrence and unit cell constants are reported for 10 ternary compounds formed when Y, Sm, Gd, Tb, Dy, Ho, Er, Tm, Yb or Lu are alloyed with Ni and Ga in equiatomic proportions. These are members of a family of orthorhombic compounds with the $CeCu_2$-type structure. From X-ray diffraction data on powdered specimens, approximate atomic positional parameters and interatomic distances were obtained. An examination of the structure indicates that the rare earth atoms are aligned parallel to the *b* axis of the unit cell while the Ni and Ga atoms are aligned parallel to the *a* axis. The effect on the unit cell dimensions of ternary and quaternary substitutions are discussed. Author

N67-36323# Oak Ridge National Lab., Tenn.
CHEMICAL AND ELECTRON OPTICAL STUDIES OF SOLS, GELS, AND OXIDE MICROSPHERES PREPARED FROM RARE-EARTH HYDROXIDES
C. J. Hardy, S. R. Buxton, and T. E. Willmarth *In its* 6th Rare Earth Res. Conf. [1967] p 175–186 Sponsored by AEC (See N67-36303 21-06)

Preparation of europium, neodymium, and praseodymium hydroxide sols and gels are discussed; and colloidal particles are characterized by chemical analysis, spectroscopy, electron microscopy, and electron diffraction measurements. Microsphere gels were calcined to dense oxides whose carbon contents were only between 0.002 and 0.005 wt%. Structure of precipitates and sols of rare earth hydroxides is discussed, along with that of the hydroxide gels and oxide spheres. M.W.R.

N67-36324# Naval Research Lab., Washington, D. C.
STRUCTURE OF LANTHANUM DIHYDROXY CHLORIDE
Forrest L. Carter *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 187–193 refs (See N67-36303 21-06)

Prepared hydrothermally $La(OH)_2Cl$ crystallizes in a monoclinic form with unit cell parameters of $a = 6.318$Å, $b = 3.993$Å, $c = 6.931$Å, and $\beta = 113.86°$. The structure is non-centrosymmetric and belongs to the $P2_1$–C_2 space group. Lanthanum has a coordination sphere of eight, of which two chlorines and four oxygens form a distorted trigonal prism. The structure is primarily a layer type with a structural backbone of lanthanum and oxygen. Hydrogen bonds between the hydroxyl groups and chlorine are responsible for the interlayer bonding. Author

N67-36325# Pennsylvania State Univ., University Park. Materials Research Lab.
CRYSTAL CHEMISTRY AND PHASE EQUILIBRIA IN THE SYSTEM Eu–Ti–O
Gregory J. McCarthy, William B. White, and Rustum Roy *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 194–199 refs (See N67-36303 21-06)

The crystal chemistry and phase equilibria of the ternary system Eu–Ti–O was investigated in open and closed systems in the temperature range of 900 to 1500°C. The known bounding binary systems include the compounds Eu_2O_3–Eu_3O_4–EuO–Eu on the europium–oxygen side and TiO_2—the Ti_2O_{2n-1} homologous series—Ti_3O_5–Ti_2O_3–TiO–Ti_2O–Ti_3O–Ti on the titanium-oxygen side. The join Eu_2O_3–TiO_2 contains in addition to the known pyrochlore structure $Eu_2Ti_2O_7$, the monoclinic compound Eu_2TiO_5. On the joins Eu_2O_3–Ti_2O_3 and EuO–TiO_2, the perovskite $EuTiO_3$ with divalent europium and tetravalent titanium is shown to have an extremely wide range of stability. The join EuO–TiO is apparently not binary and bulk compositions along this join dissociate into oxygen-rich and oxygen-poor phases. Particular attention was placed on the highly reduced compounds in the metal-rich section of the diagram because of the possibility of finding compounds with unusual electrical properties. Author

N67-36326# DuPont de Nemours (E. I.) and Co., Wilmington, Del. Experimental Station.
SOME TENSIMETRIC STUDIES OF THE SYSTEM $Ce_yTb_{1-y}O_x$.
J. Kordis and LeRoy Eyring (Ariz. State Univ., Univ. Park) *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 200–212 refs (See N67-36303 21-06)

A study of the system $Ce_yTb_{1-y}O_x$ reveals the effect of cation substitution between analogous systems on their thermodynamic behavior as determined by tensometric measurements. Mixed oxides were prepared at intervals of 10 atom percent cerium and isobaric studies were made at oxygen pressures between 10^{-3} and one atmosphere. For one particular mixed oxide, $Ce_{0.2}Tb_{0.8}O_x$, isothermal studies (10^{-5} to one atmosphere) were made. To a first approximation there is no valency stabilization of the TbO_x by the presence of CeO_x; however, a careful examination of the isobars reveals the existence of a widely nonstoichiometric phase in the mixed system which is observed in the pure PrO_x system but not in the pure TbO_x. Apparent hysteresis and pseudo phase formation appear which are characteristic of the behavior of the pure TbO_x and PrO_x systems. There is a general "smearing out" of the isobars indicating less definite intermediate phases of narrow composition range and two-phase regions. Author

N67-36327# Pennsylvania State Univ., University Park. Materials Research Lab.

EQUILIBRIA, POINT DEFECT NATURE AND KINETICS IN THE SYSTEMS OF RARE EARTHS AND DIVALENT OR TETRAVALENT OXIDES

Rustum Roy, A. M. Diness, and T. L. Barry *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 213–222 refs Sponsored by AFOSR (See N67-36303 21-06)

Quenching, DTA, high temperature, X-ray and high-pressure water catalysis studies were made on the systems $CaO–Yb_2O_3$, $CaO–Gd_2O_3$, $CaO–La_2O_3$, $ThO_2–Yb_2O_3$, $ThO_2–Gd_2O_3$, and $ThO_2–La_2O_3$. New or revised equilibrium diagrams are presented for all the systems, and a large number of new compounds are reported. In the $CaO–Yb_2O_3$ system, for example, there are four compounds that decompose below 1800°C. In the $ThO_2–La_2O_3$ system, there are two previously unreported compounds. The extent of crystalline solubility of the rare earths in CaO and ThO_2 does not follow the expected dependence on ionic radii or ionic field strength differences. An anion vacancy model for ThO_2 (matrix)–Ln_2O_3(solute) solutions near 1900°C, a cation vacancy model for $CaO–Ln_2O_3$, and an interstitial anion model for the $Gd_2O_3–ThO_2$ are confirmed. The kinetics of the solid state decomposition of $CaYb_2O_4 \rightarrow CaO + Yb_2O_3$ follows zero order kinetics.

Author

N67-36329# Paris Univ. (France).

CRYSTAL STRUCTURES OF SULFIDES Yb_3S_4 AND MnY_2S_4R.

Chevalier, P. Laruelle, and J. Flahaut *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 225–227 (See N67-36303 21-06)

Crystallographic studies were made of the ytterbium sulfide, Yb_3S_4, and the manganese ytterbium sulfide, $MnYb_2S_4$. The former was obtained by the action of H_2S on Yb_2O_3 above 1300°C, and crystals isolated after melting in H_2S atmosphere had the composition $YbS_{1.37}$. The $MnYb_2S_4$ was obtained by the action of H_2S on the mixture of Mn_3O_4 and Yb_2O_3 or on the mixture of MnS and Yb_2S_3. Both compounds have very similar Debye–Scherrer diffraction patterns, but preliminary examination of monocrystals by precession methods indicates their space groups are different.

M.W.R.

N67-36330# Radio Corp. of America, Princeton, N. J.

THE RARE EARTH CHEMISTRY OF LASERS

P. N. Yocom *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 228–238 refs (See N67-36303 21-06)

Laser physics are discussed to show that the important quantities for obtaining laser action are the frequency of the transition, the fluorescent linewidth, the dipole moment matrix element of the transition, and the cavity properties. Both divalent and trivalent lanthanide ions can provide the needed properties. Crystal lasers are presented on the basis of the charge on the ion replaced by the lanthanide ion, including the properties and preparation of divalent lanthanide ions and the charge compensation of the trivalent ions in divalent sites. Sensitization in crystalline hosts and line broadening are discussed. The glasses containing lanthanide ions that show laser action are described and the effects of a glass matrix on the properties of the lanthanide ions are discussed. Rare earth chelate systems that show laser action and the inorganic, non-aqueous, liquid laser system are considered.

Author

N67-36333# Los Alamos Scientific Lab., N. Mex.

THE ENERGY LEVELS OF TETRAVALENT DYSPROSIUM. FLUORESCENCE AND ABSORPTION SPECTRA OF CESIUM DYSPROSIUM (IV) HEPTAFLUORIDE

Louis P. Varga (Okla. State Univ.) and Larned B. Aspray *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 259–270 refs (See N67-36303 21-06)

Absorption and fluorescence spectra of fluorocarbon mulls of cesium dysprosium (IV) heptafluoride at liquid nitrogen temperature were recorded by spectrophotometers. Approximate centers of the six energy levels above ^7Fe ground state were found for J values of 5,4,3,2,1, and 0. Excitation of fluorocarbon mulls of Cs_3DyF_7 at 4050 Å resulted in fluorescence at 5250 Å and a weaker line at 6300 Å; and the $^5D_4$ level of Dy(IV) was placed at near 21,000 cm^{-1}, some 600 cm^{-1} above the Tb(III) level. An energy level diagram compares several unusual oxidation states of the lanthanides, and evidence for the higher oxidation state of dysprosium is given. The orange material resulting from the fluorination of cesium salts of dysprosium containing 3:1 mole ratio Ce:Dy was compared by middle and near infrared absorption spectroscopy and by visible fluorescence spectroscopy with the corresponding energy transition levels of Tb(III) in order to identify and characterize the levels of the isoelectronic f^0 configuration of Dy(IV).

M.W.R.

N67-36335# Centre National de la Recherche Scientifique, Bellevue (France).

PREPARATION AND PROPERTIES OF SOME FLUORESCENT RARE EARTH COMPOUNDS

Jean Loriers and Rudolf Heindl (Lab. Central des Telecommun.) *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 283–294 refs (See N67-36303 21-06)

Preparation and properties of some fluorescent inorganic rare earth compounds derived from the orthovanadates of general formula Yt VO_4 (Yt=Y, Gd, Lu or Sc) by balanced cation-substitution are described. Double and polycationic-orthovanadates with zircon structure and $ABVO_4$-type compounds are considered. When doped with europium or other lanthanides, these compounds have fluorescent properties similar to those observed with yttrium orthovanadate as host material. The fluorescence spectra under ultraviolet excitation have some interesting properties compared with those of usual fluorescent orthovanadates. The influence on intensity of emission lines is studied with respect to changes in substitution elements and concentration of doping lanthanide.

Author

N67-36341# Los Alamos Scientific Lab., N. Mex.

HIGH-TEMPERATURE NEUTRON DIFFRACTION STUDY OF LaC_2 AND YC_2.

A. L. Bowman, N. H. Kirkorian, G. P. Arnold, T. C. Wallace, and N. G. Nereson *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 311–317 refs Sponsored by AEC (See N67-36303 21-06)

The dicarbides of lanthanum and yttrium were examined by high-temperature neutron and X-ray-diffraction and by thermal analysis. A tetragonal to cubic transformation has been observed at 1060° for LaC_2 and at 1320° for YC_2. The lattice parameters of LaC_2 are a=4.00, c=6.58A at 900° and a=6.02A at 1150°. The parameters of YC_2 are a=3.74, c=6.20A at 1100° and a=5.66A at 1400°. The structure of the tetragonal phases was found to be the C11a calcium carbide-type, in agreement with previous room temperature results. The structure of the cubic phases is the B1 sodium chloride-type with C_2 groups, similar to the structure of KCN. Both phases are isomorphous with the corresponding uranium dicarbide phases.

Author

N67-36342# Illinois Univ., Urbana. Noyes Chemical Lab.

CURRENT PROBLEMS AND STUDIES IN THE COORDINATION CHEMISTRY OF THE RARE EARTH–METAL IONS

Therald Moeller *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 318–328 refs (See N67-36303 21-06)

The structure of and bonding within the complex species, the thermodynamic stabilities of the complex species in solution, those properties that arise from *f* configurations, and the applications that depend upon specific properties of individual complexes are discussed. Structural studies, although still infrequent and limited

in number, support the view that coordination number six and octahedral geometry are the exception rather than the rule. Higher coordination and spatial arrays that are uncommon among complexes derived from the *d*-transition-metals are important. Although the bonding between cation and ligand is, by general agreement, primarily electrostatic in nature, small but significant covalent contributions are indicated by spectral and other studies. Author

N67-36343# Iowa State Univ. of Science and Technology, Ames.
OM_4 TETRAHEDRON LINKAGES—AN IMPORTANT FEATURE IN RARE EARTH OXIDE AND OXYSALT STRUCTURES
Paul E. Caro *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 329–340 refs (See N67-36303 21-06)

Rare earth oxides and oxysalt structures are considered with respect to the coordination of the oxygen atom. Metallic atoms are found to be in tetrahedral positions around the oxygen atom, and all known structures can be described as tridimensional or bidimensional packing of OM_4 tetrahedra joined together by sharing of edges. In A–M_2O_3, B–M_2O_3 structures and the oxysalts the packed tetrahedra appear as an infinite polymeric complex cation $(MO)_n^{n+}$. Possible implications for the structure of non-stoichiometric oxides are discussed. Optical studies show that the rare-earth atoms in oxides are to some extent covalently bonded, and it is suggested that the oxygen atoms are involved in a directional bonding, possibly of a sp^3 type. Author

N67-36344# Argonne National Lab., Ill.
LIQUID–LIQUID EXTRACTION DISCRIMINATION AMONG RARE EARTHS
D. F. Peppard and G. W. Mason *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 341–342 Sponsored by AEC (See N67-36303 21-06)

In the application of liquid–liquid extraction techniques to the large scale processing of rare earths, a prime consideration is the single-stage discrimination among the lanthanide (III) consituents of the feed. This discrimination is best shown, in an over-all fashion, by a log K vs. Z plot. In such a plot, a straight line passing through all 15 points corresponds to a constant separation factor, *r*, between *any* two adjacent members. Such a straight line plot is seldom encountered, the more usual log K vs. Z plot indicating much more promising separations possibilities in one Z range than in another. In some instances, the data are best correlated by use of two curves, one for the odd-Z elements and the other for the even-Z. The principal factors determining the shape of the log K vs. Z curve in systems involving acidic extractants are discussed. Author

N67-36345# Iowa State Univ. of Science and Technology, Ames. Inst. for Atomic Research.
AUGMENTING THE SEPARATION OF GADOLINIUM AND EUROPIUM AND EUROPIUM AND SAMARIUM MIXTURES IN ION EXCHANGE ELUTIONS WITH EDTA
J. E. Powell and H. R. Burkholder *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 343–354 refs Sponsored by AEC (See N67-36303 21-06)

Thermodynamic data and proposed models for the hydrated ethylenediaminetetraacetato chelates of the rare earths as a means of improving displacement chromatographic separations of Gd–Eu and Eu–Sm mixtures on cation exchange columns are discussed. Increasing the operating temperature from 25 to 92°C was found to effect an increase in the Gd–Eu separation factor from a skimpy 1.1 to a robust 1.47±0.7 and the Eu–Sm separation factor from 1.4 to 1.8, presumably by destroying a degree of internal hydrogen bonding which occurs to a varying extent in the case of the less constrained lighter rare earth EDTA chelates at room temperature. Apparently this type of internal hydrogen bonding is not possible in the case of the smaller heavier rare earth EDTA chelates (Gd through Lu). This interesting and important effect has been correlated with a similar trend noted in the stability behavior of terbium, dysprosium and holmium β-hydroxyethylethylenediaminetriacetates with increased temperature. Author

N67-36346# Los Alamos Scientific Lab., N. Mex.
A STUDY OF SOME GEOMETRICAL AND MECHANICAL EFFECTS ON THE EXTRACTION OF EUROPIUM BY LITHIUM AMALGAM FROM AQUEOUS LITHIUM CITRATE ELECTROLYTES
John B. Goddard, John M. Campbell, and E. I. Onstott *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 355–363 *ref* Sponsored by AEC (See N67-36303 21-06)

The amount of Eu extracted into lithium amalgam from aqueous lithium citrate electrolytes was enhanced when the phases were separated by dumping the amalgam and electrolyte from the reaction vessel into a second vessel containing a chloroform layer to constrain the electrolyte phase. As much as 39% of the Eu in the electrolyte was extracted in a time interval estimated to be less than one second using this phase separation procedure. If the phases were separated by a second technique by adding the chloroform layer to the reaction vessel, other conditions remaining the same, the amount of Eu removed in this short time interval was reduced to 3.5%. The amount of Eu extracted by this faster mechanism was found to increase with the amount of amalgam used whereas the steady-state rate was inversely dependent on this parameter. Surface area of the amalgam exposed to the electrolyte affected the steady-state extraction rate in the expected manner with the rate being proportional to surface area. Author

N67-36347# Battelle Memorial Inst., Columbus, Ohio.
ION-EXCHANGE PURIFICATION OF PROMETHIUM AND THE PREPARATION OF Pm_2O_3
E. J. Wheelwright *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 364–365 (See N67-36303 21-06)

Optimum conditions for the purification of the individual light rare earth elements by ion-exchange elution were determined for the eluting agents EDTA, HEDTA and DTPA. These conditions apply directly to the isolation of macro quantities of pure Pm from the fission product rare earths. A modified DTPA elution process is shown to be optimum. The substitution of Zn^{+2} for H^+ as the "barrier" ion permits an increase in the eluant concentration from 0.025 to 0.050 M DTPA; resulting in a 50% reduction of both the time cycle and the volume of waste generated. When 8% cross-linked resin is used and the resin beds maintained at 60–70°C, the absorbed rare earth band can be advanced down the resin at rates up to 18 cm/hr without significant loss of separation efficiency. Author

N67-36348# Los Alamos Scientific Lab., N. Mex.
THE PREPARATION OF THORIUM DICARBONATE, URANYL CARBONATE AND THE SESQUICARBONATES OF La, Ce, Pr, Tb and Y FROM THE CORRESPONDING ANHYDROUS ACETATES
E. L. Head *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 366–373 refs Sponsored by AEC (See N67-36303 21-06)

Two methods for the preparation of the rare earth sesquicarbonates have been described at previous rare earth conferences. This paper represents a continuation of those studies and describes a method for the preparation of La, Ce, Pr, Tb, and Y sesquicarbonates; thorium dicarbonate; and uranyl carbonate from their respective anhydrous acetates. Methods are described for the preparation of the various anhydrous acetates used. Typical analytical data for the compounds prepared and thermal decomposition diagrams for the thorium dicarbonate and uranyl carbonate are given. The method consistently produced carbonate product yields of about 75 to 80% for the sesquicarbonates, 90 to 95% for thorium dicarbonate, and 90 to 93% for uranyl

carbonate. Use of the hydrated acetate salt in the case of La, Ce, and Pr produced carbonates which were much more difficult to filter and in yields of less than 50%. Author

N67-36349# Michigan State Univ., East Lansing. Dept. of Chemistry.
PREPARATION, CHARACTERIZATION, AND SOME THERMODYNAMIC PROPERTIES OF LANTHANUM–OXIDE–CARBIDE, $La_2O_2C_2$
A. Duane Butherus and Harry A. Eick *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 374–384 refs Sponsored by AEC (See N67-36303 21-06)
(COO-716-027)

A lanthanum–oxide–carbide of the general formula $La_2O_2C_2$ was prepared by the reaction of molten lanthanum metal with carbon monoxide, by the reaction of lanthanum metal with the sesquioxide and carbon, by the reaction of lanthanum dicarbide with the sesquioxide and carbon, and by the reaction of sesquioxide with graphite. All reactions were carried out in a carbon monoxide atmosphere. Some of the preparations which were zone refined by slow passage of an arc over an approximately 7 cm long sample produced a crystalline phase which both X-ray powder diffraction and micrographic analysis indicated to be monophasic. Analysis of this specimen for total carbon, free carbon, and metal indicated the composition mentioned previously. Vapor phase chromatographic analysis of the acid hydrolysis product indicates the principal species to be acetylene. A carbon monoxide equilibration study was undertaken on the reaction $La_2O_3(s) + 3\ C(s) = La_2O_2C_2(s) + CO(g)$. Author

N67-36350# Freiburg Univ. (West Germany).
PRECIPITATION OF RARE EARTH OXIDES FROM MOLTON SALTS
Georg Brauer *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 385–390 refs (See N67-36303 21-06)

Rare earth oxides or oxide nitrates were precipitated from anhydrous rare earth nitrates dissolved in molten mixtures of alkali nitrates by self-decomposition at 400°C. La and Nd form oxide nitrates under these conditions. Ce, Pr, and Tb are precipitated as higher oxides CeO_2, $PrO_{1.83}$, and $TbO_{1.80}$ respectively. The other rare earths are precipitated as sesquioxides with the B-type structure (Sm, Eu, Gd) or with the C-type structure (Dy the really stable phases at 400°C. A new version of the phase stability diagram of the A-, B-, and C-type polymorphs of the rare earth sesquioxides has been proposed. Author

N67-36351# Autonetics, Anaheim, Calif.
THE DIVALENT STATE IN LANTHANIDES
C. G. Kirkpatrick *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 391 (See N67-36303 21-06)

The lanthanide elements (atomic numbers 58-71) have long been considered a stable trivalent species, except for ytterbium, europium and sometimes samarium. It is now apparent that this belief rested largely on the use of aqueous solvents in which the studies were conducted. The advent of optical master phenomena involving the rare earths, and subsequent investigations in crystalline and glassy media, have made the trivalent question a good deal less clear. A model was proposed for divalent laser materials. The model proposed postulated that (1) the ease of reduction of rare earth impurities is dependent on the third ionization potential of the impurity, (2) the reduction technique must raise the fermi level above the level of the divalent ion, and (3) the temperature of crystal growth must be low enough that trapped electrons can remain on divalent sites. Author

N67-36352# Rajasthan Univ., Jaipur (India). Chemical Labs.
ALKOXY AND ACYLOXY DERIVATIVES OF LANTHANONS
R. C. Mehrotra, J. M. Atwara, S. N. Misra, T. N. Misra, and U. D. Tripathi *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 392–402 refs Sponsored by Atomic Energy Estab. of India (See N67-36303 21-06)

The preparation and properties of alcoholates, $MCl_3 \cdot 3ROH$ (where M is La, Ce, Pr, Nd, Gd, Er or Yb and R is Me, Et, Pr^i or Bu) are described. The reactions of these alkoxides particularly of isopropoxides were studied in benzene medium with acetyl chloride, acetyl bromide, phenols, glycols, β-diketones and β-ketoesters. A wide variety of metallo-organic compounds including anhydrous β-diketonates of lanthanons were synthesized for the first time. The acyloxy derivatives, $M(OOCR)_3$(where M is La, Ce, Pr and Nd and R is $C_{11}H_{23}$, $C_{15}H_{31}$, $C_{17}H_{35}$) have been synthesized by treating their chlorides or nitrates with appropriate sodium soap solutions in water. Author

N67-36369# Argonne National Lab., Ill.
THE HEAT CAPACITY OF SCANDIUM FROM 1 TO 23°K
Howard E. Flotow and Darrell W. Osborne *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 534–545 refs Sponsored by AEC (See N67-36303 21-06)

The heat capacity of a well-characterized, polycrystalline scandium sample was measured from 0.9 to 23°K. The results are in reasonable agreement with previous measurements below 4°K, except that a small anomalous addendum to the heat capacity was detected. This anomaly follows a T^{-2} dependence down to 2.9°K, rises to a maximum of about 1.3 mJ deg^{-1} (g at. Sc)$^{-1}$ near 1.2°K, and has an associated entropy of 3.2 mJ deg^{-1} (g at. Sc)$^{-1}$. It is believed to be due to small concentrations of magnetic impurities found in the sample. An evaluation of the results from 2.9 to 8.4°K gave $\gamma = 10.66 \pm 0.10$ mJ deg^{-2} (g at.)$^{-1}$ and $\theta = 359.5 \pm 4.2$°K. A table of smoothed heat capacities and thermodynamic functions for scandium at selected temperatures between 5 and 298.15°K is presented. Author

N67-36370# Pittsburgh Univ., Pa. Dept. of Chemistry.
CRYSTAL FIELD HEAT CAPACITIES OF $PrNi_2$ AND PrBi
M. Dixon, M. Aoyagi, R. S. Craig, and W. E. Wallace *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 546–555 refs Sponsored by Army (See N67-36303 21-06)

Heat capacities of $PrNi_2$, $CeNi_2$, PrBi and LaBi have been measured from 1.5°K to 300°K. The first two compounds are cubic Laves phases while the latter two have the NaCl structure. One of the objectives of this investigation was to evaluate the crystal field heat capacity of $PrNi_2$. The heat capacity of $CeNi_2$ was measured in order to obtain an estimate of the vibrational contribution, the difference in heat capacity between $CeNi_2$ and $PrNi_2$ being taken as the crystal field heat capacity of the latter. The excess heat capacity of $PrNi_2$ is observed as a broad maximum at about 12°K. The excess heat capacity below 30°K is considerably larger than is expected from the crystal field contribution. The heat capacity of $CeNi_2$ exhibits an anomaly in the liquid helium temperature range. It is suggested that the anomaly results from a small population of trivalent Ce ions which begin to order at about 2.5°K. Author

N67-36372# National Research Council of Canada, Ottawa (Ontario). Div. of Pure Chemistry.
ANALYSES OF LOW-TEMPERATURE HEAT CAPACITIES OF THE RARE-EARTH METALS
J. A. Morrison and D. M. T. Newsham *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 568–580 refs (See N67-36303 21-06)

Low-temperature heat-capacity data for the rare-earth metals have been reanalysed and somewhat different results have been obtained for individual contributions to the total heat capacity of several of the metals. Since the proportions of the different contributions vary from metal to metal, and with temperature, we stress the advantages of a graphical analysis as opposed to a

standardised (computer) analysis such as that adopted by Lounasmaa *et al.* For each metal considered, the analysis gives the coefficient of the electronic contribution, and the coefficient of the leading term in the series expansion for the nuclear-hyperfine contribution, to an accuracy comparable to that of the experiments (a few percent at worst). For Yb and Lu, estimates of the lattice contributions have been obtained. For only four of the metals (Pr, Nd, Eu and Tm) is the magnitude of the magnetic contribution to the heat capacity large enough for its form to be determined. For these metals, the magnetic heat capacity seems to have an exponential temperature dependence. Author

N67-36380# Lunex Co., Pleasant Valley, Iowa.
CHEMICAL ASPECTS OF INDUSTRIAL PREPARATION OF THE RARE EARTH METALS
J. L. Moriarty *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 653–664c refs (See N67-36303 21-06)

This paper is intended to be a review covering more than ten years experience with the industrial process chemistry involved in producing rare earth metals. Fluoride and chloride preparatory methods are discussed along with tabular presentations of some physical property data. Metallothermic reduction techniques as applied to both processes are shown. Also a comparison of representative metal microstructures and conversions in excess of 97 per cent and yields of recovered metal to range from 77 to 86 per cent of theoretical. Average typical Spectrographic and gas analyses indicate that a final product purity of 99.9+per cent is common for the metals prepared. The thermodynamic and vapor pressure characteristics of several of the rare earths permits direct reduction of their oxide to metal. High purity metals behave nicely and can be readily cast, rolled and machined under the appropriate conditions. In producing the rare earth elements on a commerical scale numerous factors such as optimum purity, availability, marketability, demand, economics, and equipment requirements must be carefully considered. Author

N67-36381# Iowa State Univ. of Science and Technology, Ames. Inst. for Atomic Research.
RARE EARTH SEPARATION SOLVENT: TBP VS. D2EHPA?
G. A. Elias, R. F. Sebenik, and M. Smutz *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 665–666 (See N67-36303 21-06)

A computer program was written for TBP rare earth nitrate acid systems to predict the return on investment for a processing plant as a function of both operating conditions and cost estimates. A small-scale continuous extractor is being operated with D2EHPA as the solvent in order to estimate optimum operating conditions for the desired separation. These two solvents are being compared for the recovery of 99.0% of the lanthanum fed into a didymium mixture at a purity of 99.9%. Feeding is in a continuous multistage countercurrent extractor at an arbitrarily selected production rate of 2.5 tons of didymium oxide feed each day. The TBP has a significantly higher distribution coefficient for rare earths, so that less solvent volume is required for any given production rate; while the D2EHPA has a significantly higher separation factor for P with respect to La. M.W.R.

N67-36382# Michigan Chemical Corp., St. Louis.
EFFECT OF TEMPERATURE ON THE HEDTA-ELUTION AND EDTA-ELUTION POSITIONS OF YTTRIUM IN THE RARE-EARTH SEQUENCE
J. R. Morton and D. B. James *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 667–677 refs (See N67-36303 21-06)

Varying the elution temperature in the ion-exchange separation of an yttrium–lanthanide mixture shifts the elution position of yttrium. With HEDTA as the eluant the position of yttrium at room temperature is slightly ahead of neodymium, at 90–95°C it is between terbium and gadolinium, and at 45 to 50°C it is in the vacant promethium position. A practical scheme for the purification of yttrium has been devised using this shift of position. With EDTA the elution position of yttrium is always between terbium and dysprosium; but increasing temperature decreases the dysprosium–yttrium separation factor, possibly negating any increased separation efficiency resulting from the decreased theoretical plate height. Author

N67-36383# American Potash and Chemical Corp., Los Angeles, Calif.
COMMERICAL ION EXCHANGE SEPARATION OF THE RARE EARTHS
W. L. Silvernail and M. M. Woyski *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 678–690 refs (See N67-36303 21-06)

Rapid production of yttrium is achieved by making use of the different positions of yttrium in the elution sequence with different eluting agents. Elution with HEDTA is used to separate the heavy elements, followed by elution with EDTA to separate the lights. Elution with EDTA is carried out with a pre-prepared solution of rare earth chelate. This permits operation at much higher concentration and facilitates the recovery of EDTA. The use of non-rare earth retainers is eliminated. In actual operation, columns loaded with crude material are introduced into the elution train at suitable intervals to provide almost continuous production of purified product. The use of pre-prepared solutions of rare earth chelates is also applicable to the separation of other rare earths with a gain in operating efficiency. Some fundamentals of commercial ion exchange operations are considered. Author

N67-36384# Bureau of Mines, Reno, Nev. Metallurgy Research Center.
RECOVERY OF CERIUM AND LANTHANIUM BY OZONATION OF LANTHANIDE SOLUTIONS
D. J. Bauer and R. E. Lindstrom *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 691–700 refs (See N67-36303 21-06)

Oxidation of lanthanide solutions with ozone at pH 4.5 and ambient temperature results in precipitation of 98% of the original cerium present. Corresponding cerium purity is increased from 50 to 98%. Ozonation at pH 6.5 and 85°C differentially precipitates cerium and heavier elements, and leaves 89% of the original lanthanum in solution at a purity of 95%. Subsequent recovery of cerium from the heavier elements is accomplished by dissolving the precipitate and reoxidizing the cerium with ozone at pH 4.5 and ambient temperature. The filtrate contains an enriched praseodymium–neodymium–samarium–europium mixture that is amenable to separation by ion exchange or solvent extraction. Author

N67-36385# Molybdenum Corp. of America, Pittsburgh, Pa
COMMERCIAL PRODUCTION OF EUROPIUM OXIDE
Paul R. Kruesi *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 701 (See N67-36303 21-06)

Mention is made of a commercial plant that produces europium oxide on a large-scale. No details are included. M.W.R.

N67-36386# Th. Goldschmidt A. G., Essen (West Germany).
A CRACKING PROCESS FOR RARE EARTH ORES BY DIRECT CHLORINATION AT HIGH TEMPERATURES ON A PRODUCTION SCALE
W. Brugger and E. Greinacher *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 702–713 refs (See N67-36303 21-06)

The direct chlorination of rare earth ores without resorting to carbides or similar compounds is described. Complete chlorination of all non-volatile components of the ore results between 1000°C and 1200°C in a special electrically heated furnace. The furnace

is so constructed that it is possible to replace the most vital parts quickly and in a hot furnace, thereby bringing under control the unavoidable effects of corrosion. The flow sheet of the process is presented. The process permits a large productive capacity in a small space at low investment to the problems of conversion of off-gases. As final product one obtains fused anhydrous chlorides of the rare earths without thorium chloride and without oxychloride content. These chlorides are very well suited for the production of the corresponding metals. With a similar process one can also convert pure rare earth oxides to the corresponding anhydrous chlorides. Author

N67-36387# Bureau of Mines, Reno, Nev. Metallurgy Research Center.

DIRECT ELECTROLYSIS OF RARE-EARTH OXIDES TO METALS AND ALLOYS IN FLUORIDE MELTS

E. Morrice, E. S. Shedd, and T. A. Henrie *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 715-727 refs (See N67-36303 21-06)

Techniques developed by the Federal Bureau of Mines for the preparation of high-purity rare-earth metals and their alloys by electrolysis of the oxides in fluoride media are discussed. Individual cerium, lanthanum, neodymium, praseodymium, dysprosium, gadolinium, and yttrium metals, as well as the mixture "didymium", and specific alloy compositions of these metals and samarium with iron, nickel, chromium, and cobalt, were prepared. Individual metals were electrodeposited in the liquid state on tungsten or molybdenum cathodes. Alloys were prepared by electrodepositing the rare-earth metal on a consumable base metal cathode at a temperature above the melting point of the eutectic formed between the rare-earth element and the cathode material. Cells for electrowinning metal products in gram and pound quantities, along with methods for the continuous electrowinning of cerium and lanthanum, are described. Author

N67-36388# Ronson Metals Corp., Newark, N. J.

COMMERCIAL PRODUCTION OF RARE EARTH METALS BY FUSED SALT ELECTROLYSIS

I. S. Hirschhorn *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 728-739 refs (See N67-36303 21-06)

The commerical production of rare earth metals by fused salt electrolytic methods is described. These methods are used to make mischmetal, cerium, lanthanum and didymium (Nd+Pr). The feed materials consist essentially of anhydrous chlorides of the metal to be produced, augmented by additions of non-rare earth salts to yield an electrolyte with satisfactory properties for reduction. The rare earths are derived either from monazite or from bastnasite ores. The anhydrous chlorides are manufactured from the hydrated chlorides by methods which minimize oxidation or hydrolysis. Alternatively, anhydrous chlorides may be used which result from the direct chlorination of rare earth ores by the Goldschmidt process. These are particularly suitable for electrolysis due to their very low oxychloride content. Fluorides and oxides of the rare earths are produced by wet chemical methods to provide the relatively small quantities of these compounds now used for commercial fused slat electrolysis. Reduction cells in use today are constructed mainly from ceramic, graphite, or iron. The advantages and disadvantages of these types of cells are described together with typical products which result from their use. Primary attention is given to production of mischmetal (mixed rare earth metal), which is the rare earth metal produced on the largest scale today. Brief reference is made also to production of cerium, lanthanum and didymium (Nd+Pr) metal. Finally, a resume of the current uses of these metals is presented with reference to recent trends in the industrial applications of the rare earth metals. Author

N67-36399# Parametrics, Inc., Waltham, Mass.

DEVELOPMENT OF Kr-85 AS A UNNVERSAL TRACER Final Report, Dec. 1, 1964-Nov. 30, 1966

Orlando Cucchiara and Philip Goodman May 1967 30 p refs (Contract AT(30-1)-2757)
(NYO-2757-6) CFSTI: HC$3.00/MF$0.65

WEAR—analysis using krypton-85-labeled solids; PHOSPHORS—preparation of krypton-85 excited; CALCIUM SILICATES, ZINC SILICATES, ZINC SULFIDES, ZINC GERMANATES, CADMIUM CHLOROPHOSPHATES; STEEL—krypton-85 incorporating in; HYDROGEN—detection using krypton-85-labeled platnium dioxide sensors; KRYPTON-85—incorporation into solids; use as tracer. NSA

N67-36420*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

PHOTODESORPTION OF OXYGEN FROM NICKEL OXIDE POWDER

Paul A. Faeth Washington, NASA, Sep. 1967 15 p refs (NASA-TN-D-4160) CFSTI: HC$3.00/MF$0.65 CSCL 07B

The photodesorption of oxygen from nickel oxide was studied at room temperature using 635, 705, and 1070 millimicron light. These wavelengths produced photodesorption similar to that of white light. First-order and logarithmic sorption processes are demonstrated to occur during illumination. The rate of logarithmic uptake kinetics, normally measured in the dark, appears to increase during illumination. Sorption kinetics after light cessation are first order with the rate constants $k_A = 1.4$ per minute and $k_D = 1.1$ per minute. Pretreatment of the nickel oxide surface with infrared light decreases the rate of oxygen uptake, presumably by decreasing the number of activated adsorption centers. Author

N67-36423# Technische Hochschüle München (West Germany). Fakultaet fuer Allemeine Wissenschaften.

CONTRIBUTIONS TO THE SPECTROSCOPY OF THE CYANINE DYES DELAYED FLUORESCENCE, LUMINESCENCE EXCITATION DISTRIBUTION [BEITRAEGE ZUR SPEKTROSKOPIE DER CYANINFARBSTOFFE VERZOEGERTE FLUORESZENZ, LUMINESZENZER-REGUNGSVERTEILUNG]

Leo Repper (Ph.D. Thesis) 1965 26 p In GERMAN

An attempt was made to control quantum yield and decay time of the delayed fluorescence of cyanine dyes by means of electron acceptors. It was not possible to obtain definite information on the effect of the acceptors. In aqueous solution and with the electron acceptor iodine added, the cyanine dyes reveal a new long-wave absorption capacity, which is possibly a charge transfer complex as determined by Mulliken. A study of the distribution of the luminescence excitation showed that contrary to expectations, the distribution of fluorescence and phosphorescence excitations varies greatly. It appears that the phosphorescence is particularly intensive in the cis- form and during excitation toward the higher oscillation states of the first singlet electron excitation state of the trans- form. Assuming that the cis- form is stronger phosphorescent, this may be indicative of a wave length dependence for the quantum yield of the isomerization process trans--cis. Transl. by K.W.

N67-36437# National Bureau of Standards, Washington, D. C.

TABLES OF MOLECULAR VIBRATIONAL FREQUENCIES, PART I

Takehiko Shimanouchi (Tokyo Univ.) 1 Mar. 1967 62 p refs (NSRDS-NBS-6, Pt. I) GPO: $0.40

Fundamental vibrational frequencies of 59 molecules are presented together with vibrational assignments, sources of data, brief comments, and citations of references. The fundamental frequencies are obtained mainly from the infrared and Raman spectra. When these are not available, other experimental data such as microwave results are taken into account. The selection of vibrational fundamentals from observed spectral data is based upon careful

studies of the spectral data and comprehensive mathematical analyses. These tables were designed to provide a concise summary needed for the computation of ideal gas thermodynamic properties. They may also provide a convenient source of information to those who require vibrational energy levels and related properties in molecular spectroscopy, analytical chemistry, and other fields of physics and chemistry. Author

N67-36450# International Union of Pure and Applied Physics, London (England). Commission on High Temperatures and Refractories.

BIBLIOGRAPHY ON THE HIGH TEMPERATURE CHEMISTRY AND PHYSICS OF GASES AND PLASMAS

L. Brewer, comp.—Univ. Calif., Berkeley 31 Mar. 1967 14 p refs
CFSTI: HC $3.00/MF $0.65

Related to studies on refractory materials, a bibliography is presented on the high temperature chemistry and physics of gases and plasmas. The two main areas of investigation are the reactions between gases and condensed phases, and the spectroscopy of interest to high temperature chemistry. R.U.

N67-36474# Bureau of Mines, Rolla, Mo.

VAPOR PRESSURE OF METAL HALIDES: THE $SnCl_2$–$ZnCl_2$ BINARY SYSTEM

L. C. George, J. W. Jensen, and Robert M. Doerr Sep. 1967 24 p refs
(RI-7022)

Vapor pressures of selected mixtures in the binary system $SnCl_2$–$ZnCl_2$ were measured by the static pressure method. Equations expressing the vapor pressure and the heat and free energy of vaporization as functions of temperature were developed by numerical analysis based on the sigma-plot method. It was found that the vapor pressure of any $SnCl_2$–$ZnCl_2$ mixture, at any temperature within the range of this investigation, could be accurately calculated from the derived values for the heat and free energy of vaporization for the mixture, with a probable error of 0.01 cm Hg or less. Author

N67-36479# IIT Research Inst., Chicago, Ill. Technology Center.

PHASE MIGRATION IN A MONOTHERMAL FIELD Final Report, Dec. 1, 1961–Nov. 30, 1966

Ted. A. Erikson 28 Mar. 1967 82 p refs
(Contract AF 49(638)-1121)
(IITRI-C212-11; AFOSR-67-1519; AD-655145)

The project was concerned with the study of various nonequilibrium processes, specifically those that can be conducted at a steady rate. New experimental data were interpreted on the basis that the properties of terminal stationary states define the steady flow of heat, mass, and/or volume across a gradient region. Data are reported for four liquids, water, carbon tetrachloride, chlorobenzene, and n-butanol, in steady force vaporization from five circular glass tubes with areas from 11 to 285 sq. mm at three temperatures, 50, 25, and near 2C over wide pressure ranges. One major point of emphasis was that data reduction is reliably established by properties of well-defined terminal regions. This is in contrast to the usual kinetic and heat-transfer approaches, in which gradients pose a serious problem for experimental verification on a microscopic basis; surface temperatures in accommodation experiments are a good example. The status of the program is reviewed, and a list of accomplishments and publications is given. Author (TAB)

N67-36483# California Univ., Los Angeles. Dept. of Physics.

FAR INFRARED SPECTRUM OF SEVERAL SALTS OF QUADRIVALENT URANIUM

Oscar M. Stafsudo, Jr. 15 Mar. 1967 85 p refs
(Contract AT(11-1)-34)
(UCLA-34P103-3; TR-1) CFSTI: HC $3.00/MF $0.65

The frequencies of the fundamental infrared active lattice modes of several salts of quadrivalent uranium were determined and compared with those determined by vibronic spectra of the same salts. The infrared frequencies range from 50 cm^{-1} to 250 cm^{-1}. A far infrared spectrometer was constructed in order to make these measurements. The spectrometer is useful over the range 25 cm^{-1} to 500 cm^{-1} and provides a resolution of at least 1 cm^{-1}. The salts investigated were Cs_2UBr_6, Cs_2UCl_6, and $[(CH_3)_4N]_2UCl_6$. Each of these salts has the uranium ion situated in the center of an octahedral complex of halogen ions. Two odd modes of this complex are infrared active and were observed both in vibronic and infrared spectra. These observations were generally in good agreement. Another odd mode of the complex in the vibronic spectra ($^3\Gamma_{5u}$) was absent in the far infrared spectra in accordance with the selection rules. The lowest frequency odd mode of the lattice can be described as the uranium halogen complex moving approximately as a ridged unit against its neighbors. This mode is also infrared active and was observed directly in the infrared and indirectly in vibronic spectra. These frequencies did not correspond closely as had the former frequencies. The interpretation given is that in the vibronic spectra, those portions of k-space with high density of states, other than k=0, are important. Author (NSA)

N67-36496# Illinois Univ., Urbana. Dept. of Chemistry and Chemical Engineering.

INTERNAL ROTATION IN LIQUID 1-FLUORO-1,1,2,2-TETRACHLOROETHANE

Terry D. Alger, H. S. Gutowsky, and R. L. Vold 13 Jun. 1967 31 p refs Submitted for publication
(Contract N00014-66-C-0010-A04)
(TR-10; AD-654483)

Fluorine and proton high-resolution NMR lineshapes were observed at 56.4 MHz and 60 MHz, respectively, for a 50 mole percent solution of 1-fluoro-1,1,2,2-tetrachloroethane in carbon disulfide, between -120C and -14C. Fluorine spin echoes were obtained at 25.27 MHz and proton spin echoes were obtained at 26.8 MHz and 17.7 MHz. An iterative complete lineshape fitting computer program was used with the experimental lineshapes to obtain best-fit exchange rates for interconversion of gauche and trans rotamers. A value of 18.9 ppm was found for the fluorine chemical shift from the low-temperature, high-resolution spectrum, and was used to fit the lineshapes at higher temperatures, as well as to fit the observed dependence of the fluorine relaxation rate of rf pulse spacing in the Carr-Purcell experiments. Other parameters required in the analysis, i.e., the energy difference between trans and gauche rotamers and the proton-fluorine coupling constants in each rotamer, were obtained from the temperature dependence of the proton spectrum under conditions of complete averaging (-90C to 25C). Because of the large fluorine chemical shift, four orders of magnitude of the exchange rate were measurable. TAB

N67-36497# California Univ., Los Angeles. Dept. of Chemistry.

A PROGRAM TO ESTABLISH THE AFOSR PROGRAM FOR SPACE CHEMISTRY Final Report, Jan. 1, 1963–Dec. 30, 1966

Willard F. Libby Dec. 1966 40 p refs
(Grant AF-AFOSR-245-65)
(AFOSR-67-1494; AD-655108)

The AFOSR Program in Space Chemistry at UCLA consists of the investigation of chemical phenomena under the conditions of outer and inner space together with peripheral but pertinent and germane activities. The primary areas studied were high pressure chemistry corresponding to the interior of the earth and other planets; high temperature chemistry corresponding to the matter in the surface of the sun or on the hotter planets; radiation chemistry - the chemical effects of ionizing radiation on matter and high vacuum chemistry; and the chemical effects of high vacuum as it exists in space, mainly the chemistry of clean surfaces. In addition, research was continued in the following areas: tritium in natural

waters and the possibility of solar production of tritium and terrestrial accretion from the solar wind; electron tunneling emphasizing the importance of the electronic Franck-Condon principle in electron transfer reactions; an intensive study of hemoglobin for the nature of the long range interaction well known to exist between the hemes; development of an organic chemical pi electron theory for metals like tin which exist in both metallic and non-metallic states. Brief summaries are given of these projects, and a list of resultant publications is included. TAB

N67-36521# Universidad Nacional Autonoma de Mexico. Villa Obregon. Escuela Nacional de Ciencias Quimicas.
DETERMINATION OF ELECTRIC CONDUCTIVITY OF ELECTROLYTIC SOLUTIONS FOR TREATMENT OF URANIUM MINERALS [DETERMINACION DE CONDUCTIVIDAD ELECTRICA EN LIQUIDOS DE UNA PLANTA DE TRATAMIENTO DE MINERALES DE URANIO CON UN PUENTE LIQUIDO BALANCEABLE A CORRIENTE DIRECTA]
Marta Rodriguez Perez 1965 59 p refs In SPANISH
(NP-16723)

A direct current liquid bridge for determination of the conductivity of electrolytic solutions was developed. It is of simple construction and is the electric circuit most sensitive for the determination. Tests made on uranyl nitrate and liquors from the alkaline leaching of uranium minerals showed that it is possible to determine the conductivity of solutions with an exactitude comparable to that obtained with very elaborate alternating current electric circuits. NSA

N67-36536# General Dynamics Corp., San Diego, Calif. General Atomic Div.
LATTICE PHYSICS STUDIES Quarterly Progress Report, Period Ending Dec. 31, 1966
T. Gozani, G. D. Trimble, and J. M. Neill 25 Nov. 1966 41 p refs Sponsored in part by EURATOM
(Contract AT(04-3)-167)
(GA-7683; EURAEC-1822) CFSTI: HC $3.00/MF $0.65

A neutron spectrum was measured in an erbium nitrate solution to study and hopefully eliminate the previous discrepancies observed in the resonance region. In order for this measured spectrum to be meaningfully compared with theory, the most recent compilation of the erbium cross section was obtained from BNL. The recommended resonance parameters are now being used to calculate the cross section below 9 eV in the desirable energy mesh (10^4 points) by the code FASDOP. The epithermal source was studied extensively in the erbium nitrate solution using the foil activation and time-of-flight methods to check new techniques of source representation. A comprehensive literature survey and methods evaluation was undertaken on uranium and plutonium lattices. NSA

N67-36585# Little (Arthur D.), Inc., Cambridge, Mass.
THE ELECTRICAL CONDUCTIVITY OF 0.10M KCl WATER–ALCOHOL SOLUTIONS UNDER HYDROSTATIC PRESSURE
R. A. Horne, D. S. Johnson, and R. P. Young 30 Jun. 1967 63 p refs
(Contract Nonr-4424(00))
(TR-28; AD-654186)

The electrical conductivities of 0.10M KCL solutions in CH3OH-H2O, C2H5OH-H2O and n-C3H5OH-H2O solutions were measured as a function of temperature, pressure, and solvent composition over the ranges 0 to 20C, 1 atm to 4,500 kgm/sq cm and 0.0 to 0.4 mole fraction alcohol. The presence of the second solvent tends to make the solution more normal by altering the structure of the bulk medium and the local structure near the ions. The order of effectiveness, n-C3H7OH > C2H5OH > CH3OH, indicates that the more dissimilar the second solvent is from water, the more normal the mixed solvent. Author (TAB)

N67-36605 Royal Aircraft Establishment, Farnborough (England).
THE PREPARATION AND FABRICATION OF AROMATIC POLYIMIDES
R. A. Dine-Hart Oct. 1965 59 p refs
(RAE-TR-65228)

Aromatic polyimides have been prepared from pyromellitic dianhydride and a range of aromatic diamines. The effect of a number of variables on the polymerisation to, and the degradation of the intermediate polypyromellitamic acids has been studied and a previously unrecorded reaction intermediate has been isolated and identified. From these studies the conditions necessary to obtain high molecular weights have been defined. Mechanically strong films and mouldings have been obtained where permitted by the diamine component. Author

N67-36607 Royal Aircraft Establishment, Farnborough (England).
A NOTE ON THE HIGH-TEMPERATURE OXIDATION OF CHLOROPHENYLMETHYL SILICONE FLUIDS
G. H. Kinner Jan. 1966 27 p ref
(RAE-TR-66011)

The results of oxidation tests at a temperature of 250°C are described for two chlorophenylmethyl silicones intended for use as high-temperature aircraft hydraulic fluids. It is shown that the extent and mode of oxidation may be significantly affected by the presence of bulk metals. Author

N67-36639*# Yale Univ., New Haven, Conn.
[RESEARCH ON GAS CHROMATOGRAPHIC SYSTEMS TO ANALYZE CERTAIN CHEMICAL CONSTITUENTS OF THE SURFACE OF THE MOON] Progress Report, 1 Jan.–30 Jun. 1967
30 Jun. 1967 4 p refs
(Grant NsG-192)
(NASA-CR-88358) CFSTI: HC $3.00/MF $0.65 CSCL 07C

The use of stop–start chromatography with mass spectrometry and infrared as a possible alternative to the use of enrichment devices for the separation and identification of organic compounds is discussed. A pyrolysis system design was assessed; and certain operating parameters such as (1) nature of carrier gas and flow rates, (2) sample size, (3) temperature, (4) duration of pyrolysis, and (5) the effect of inorganic constituents on pyrolysis patterns, were evaluated. In addition, the rapid detection of nonvolatile compounds by liquid chromatography is discussed. L.S.

N67-36644# Mound Lab., Miamisburg, Ohio.
NEUTRON MULTIPLICATION EXPERIMENT WITH ^{238}Pu DIOXIDE DOUBLE SEALED IN CALORIMETER PRESSURE CONTAINERS
R. A. Wolfe, D. A. Edling, D. F. Giessing, J. B. Kahle, and W. F. Stubbins 9 Jan. 1967 16 p
(Contract AT(33-1)-GEN-53)
(MLM-1395) CFSTI: HC $3.00/MF $0.65

The neutron multiplication of high isotopic analysis PuO_2 assembled in various planar arrays in both water and air media was determined. The isotopic distribution of the Pu was approximately 80% ^{238}Pu, 16% ^{239}Pu, 3% ^{240}Pu, and 1% ^{241}Pu. Twenty-one double-sealed calorimeter pressure containers, each containing approximately containing 130 grams of the ^{238}Pu isotope, were assembled in three planar arrays consisting of 3-in., 1-in., and 1/16-in. edge-to-edge spacing. No significant neutron multiplication was detectable in the fully assembled 1-in. planar array in the water medium or in the 3-in. planar array in the air medium. A low multiplying region ($M \approx 1.025$) did exist in the 1/16-in. planar array but was not large enough to be used in reliably extrapolating to the critical mass of ^{238}Pu. Author (NSA)

N67-36663# Technische Hochschule München (West Germany). Fakultaet fuer Allgemeine Wissenschaften.
THE AMMONOLYSIS OF CHLORINE OXIDES AND OF CHLOROXIFLUORIDES. COMPARING CONDUCTIVITY TESTS ON THE HALOGEN AMINES IN VOLATILE SOLUTION [DIE AMMONOLYSE DER CHLOROXIDE UND DER CHLOROXIDFLUORIDE. VERGLEICHENDE LEITFAEHIGKEITSUNTERSUCHUNGEN AN DEN HALOGENAMINEN IN AETHERISCHER LOESUNG]
Johann Nikolaus Meussdoerffer (Ph.D. Thesis) 1966 59 p refs In GERMAN
CFSTI: HC $3.00/MF $0.65

Conductivity measurements with monochloramine, monobromoamine, and monoiodine amine in ammonia-saturated diethyl ether solutions at −50°C resulted in the following molar conductivity order: $NH_2Cl < NH_2Br < NH_2I$. This agrees with studies of the deuterium exchange of deuterized haloforms in aqueous alkaline solutions, and it indicates that the carbanion formation from fluor to iodine is facilitated and that the constancy of the di-halogen carbenes increases from the iodine to the fluor. Unexplained remains the obtained sequence of molar conductivity of the halogen amines in ether when considering only electro-negativity of the halogens. The carbanion stability of the halogen amide ions runs parallel, which indicates that the d-orbital resonance and the polarizability are decisive factors in determining the order of molar conductivity of the halogen amines. Transl. by K.W.

07 COMMUNICATIONS

Includes communications equipment and techniques; noise; radio and communications blackout; modulation telemetry; tracking radar and optical observation; and wave propagation. For basic research see: 23 Physics, General; and 21 Navigation.

N67-35309* Washington Univ., St. Louis, Mo. Dept. of Economics.
SOME ECONOMIC PROBLEMS OF INTERNATIONAL SPACE TELECOMMUNICATIONS, VOLUME I
Edward J. Heiden (Wisconsin Univ.) Aug. 1967 141 p refs *Its* Working Paper No. 6711
(Grant NsG-342)
(NASA-CR-87991, Vol. I) CSCL 17B

The requirements for estimating Intelsat (international telecommunications satellites) rate levels and structures are assessed in terms of the types of coverage which are envisioned: telephone message service, telegraph message service, data (telex) transmission, television broadcast service, and miscellaneous. It is recognized that the requirements are satellite-specific and time-specific, and estimates are given for each hour of an average 24-hour communications day in a given year. Emphasis is focused on the extent to which (1) rate levels over time for Intelsat services are consistent with the cost of providing these services to the general public; (2) the time-specific nature of the distribution of requirements on Intelsat points to a rate structure which takes advantage of the excess capacity available on various satellites; and (3) capacity in excess of estimated requirements for communication between developed regions would be available for use by the underdeveloped areas. The evidence presented is felt to indicate that a lower rate level and variable rate structure are necessary if the full potential of Intelsat is to be realized. M.G.J.

N67-35321# Naval Research Lab., Washington, D. C.
USE OF NTDS AS A SATELLITE DISPLAY
J. R. Boller 7 Jun. 1967 21 p refs
(NRL-6544; AD-654565)

With the completion of the NRL evluation of the experimental model of the satellite position prediction and display equipment (SPAD), efforts have been directed toward the consideration of an operational version of SPAD. One possible equipment configuration, which would lead to a substantial savings in cost and development time, incorporates the SPAD functions into the naval tactical data systems (NTDS). By time sharing the NTDS computer through suitable programming, one of the display consoles in an NTDS facility could be used to present a SPAD display without interrupting service to the other NTDS displays. This proposal is based on the premise that no hardware modifications or additions are to be made to the NTDS equipment except for changing certain labels. Also the time required for switching a display console between NTDS and SPAD should be kept to a minimum. It appears that all of the original SPAD features can be incorporated into the NTDS equipment without any conflict with these ground rules. The NTDS-SPAD concept will give an NTDS-equipped ship a satellite display capability at minimal additional cost. Author (TAB)

N67-35322* Electrac, Inc., Anaheim, Calif.
STUDY REPORT FOR THE DEVELOPMENT OF TECHNIQUES TO AUTOMATICALLY ACQUIRE THE CARRIER OF AM OR PM SIGNALS
15 Jun. 1967 53 p refs
(Contract NAS5-10075)
(NASA-CR-87997) CSCL 09F

Some of the problems of fully automatic acquisition of the true carrier frequency of AM and PM signals by a phase-lock loop system operating down to its theoretical threshold are analyzed. It has been found that for AM, the carrier can be determined from the knowledge that the spectrum is symmetrical. For the PM case, however, no theory could be advanced which assures a basis for completely satisfying the originally sought goals. A simplified problem is secondarily considered which calls for semiautomatic acquisition of the carrier. Here, a system is recommended which will permit the operator to more quickly acquire the carrier and to thereafter reduce or eliminate the need for further monitoring time on his part. Author

N67-35324* Perkin-Elmer Corp., Norwalk, Conn. Electro-Optical Div.
GIANT APERTURE TELESCOPE STUDY, PHASE I
Robert W. Jones and Harold S. Hemstreet 12 May 1966 96 p refs Prepared for JPL
(NASA-CR-87987; Rept.-8393) CSCL 17H

Results are presented of the first phase of a study aimed at reducing to practice the use of giant aperture telescopes as ground receivers for spacecraft communications. Two basic high data rate communication systems are considered. One uses intensity detection and the other utilizes coherent or heterodyne detection. A communications comparison was made of the two systems to make recommendations for ground station requirements in terms of engineering feasibility, areas for further study or development, and cost. Atmospheric effects were studied and an attempt was made to predict the maximum useful aperture diameter for coherent systems at several wavelengths. Consideration was given to several different mechanical configurations of both the intensity detection receiver and the coherent systems. Results show that either incoherent ground receivers with apertures of ten meters or 10.6 micron region coherent receivers with apertures of four meters are feasible. R.N.A.

N67-35362 Massachusetts Inst. of Tech., Cambridge.
EFFECTS OF SEA REFLECTION MULTIPATH FADING ON AERONAUTICAL SATELLITE SERVICE IN THE 136 MHz BAND
J. L. Levatich 12 Oct. 1966 27 p refs

A theoretical investigation is performed to determine the effects of reflections from smooth sea water on the required power margin in aeronautical satellite service. The calculations are performed at an operating frequency of 136 MHz, for a satellite in synchronous orbit, and for circular/elliptical polarization at both the spacecraft and aircraft antennas. Author

N67-35366 Joint Publications Research Service, Washington, D. C.
NEAR EARTH AND BURIED ANTENNAS
G. A. Lavrov and A. S. Knyazev 24 May 1967 384 p Transl. into ENGLISH of the book "Prizemnyye i Podzemnyye Antenny" Moscow, Sov. Radio., 1965 p 2-461
(JPRS-41131; TT-67-31772) CFSTI: $3.00

Results of theoretical and experimental investigations of linear antennas used near the surface of the division boundary between air and earth, are presented. Methods for designing near ground and buried antennas, considering the actual electrical parameters of the soil, are given. Methods for the design of running parameters as well as mutual and natural impedances of linear radiators are also given in consideration of the influence of the semi-conducting earth. Some experimental results on antennas for mobile radios in the short wave and meter wave bands, are presented. Methods for determining the basic electrical parameters of these antennas (horizontal symmetrical and asymmetrical dipoles), and certain problems of feeding these antennas are discussed. L.S.

N67-35370*# Northeastern Univ., Boston, Mass. Communication Theory Group.
STATISTICAL COMMUNICATION THEORY Final Report, 1 Dec. 1963-31 Mar. 1967
Apr. 1967 95 p refs
(Grant NGR-22-011-013; Contract AF 19(628)-3312)
(NASA-CR-87998; AFCRL-67-0272; Rept.-8) CFSTI: HC $3.00/MF $0.65 CSCL 17B

This report describes four current research efforts: arithmetic codes, non-binary orthogonal codes, error-correcting schemes, and filtering of PAM signals for a randomly selected channel. Seven scientific reports are summarized. The subject matter of these reports includes the following topics: linear product codes, detection of digital data, optimum interpolation of sampled functions, adaptive bandwidth compression, and the design and shaping of analog signals. Author

N67-35372*# Stanford Research Inst., Menlo Park, Calif.
STUDY AND APPLICATIONS OF RETRODIRECTIVE AND SELF-ADAPTIVE ELECTROMAGNETIC WAVE CONTROLS TO A MARS PROBE Quarterly Report, 1 Oct.-31 Dec. 1966
Colin A. Hacking, James A. Martin, Charles H. Dawson, Lloyd A. Robinson, and Richard C. Kunzelman Feb. 1966 104 p refs
(Contract NAS2-2933)
(NASA-CR-73119; QR-2) CFSTI: HC $3.00/MF $0.65 CSCL 17B

Computer studies have been continued of three different cylindrical antenna configurations that could be used as adaptive arrays for deep space vehicles. Analysis of the effects of vehicle spin on gain modulation has been made. Some effects of spin on spectral splitting are superficially discussed but have not yet been analyzed. The effects of planetary reflections on a retrodirective array system have been studied. Some system aspects of a planetary mission employing retrodirective arrays are considered. A start has also been made on studying the use of an adaptive array to provide navigational information such as angle of arrival of a signal. Author

N67-35378# Syracuse Univ. Research Corp., N. Y. Defense Systems Lab.
ON-A-PULSE FREQUENCY MEASUREMENT TECHNIQUE
G. Daniel Hickman, Paul E. Harris, and David W. Johnson 28 Apr. 1967 59 p refs
(Contract Nonr-4778(00))
(DSL-R-170; AD-654931)

A technique is described for measuring the carrier frequency of a radar pulse. Two cascaded hybrids with unequal delay lines inserted between the two output ports of the first hybrid and the input ports of the second provide the frequency sensing element. The power ratio between the two output ports of the second hybrid is a sensitive function of frequency. The measurement of the log of this power ratio is converted to a time difference measurement delta t by comparison with an injector signal decaying exponentially. It is shown that this delta t is linearly proportional to frequency over an octave. Included also are the schematics and descriptions of the circuits that comprise the log-injection unit. Author (TAB)

N67-35393# Rome Air Development Center, Griffiss AFB, N. Y.
A MORE FLEXIBLE OPTICAL CORRELATOR USING ELECTRO-OPTICAL DOPPLER REPLICAS
Bernard Di Tano Apr. 1967 7 p refs
(RADC-TR-67-194; AD-654266)

The report presents the results of a theoretical investigation of optical signal processing techniques and describes a correlation technique for the processing of radar signals by means of electro-optical devices arranged in tandem. The electro-optical correlator described represents a modification to the correlators presently used in radars. The two-dimensional (range and doppler) correlation scheme eliminates the film processing by utilizing a second light modulator. A modification in the ultrasonic light modulator configuration is accomplished which enables it to be used as an electro-optical doppler replica. The two-dimensional optical correlator is a significant breakthrough in the field of radar signal processing because of its decided advantage over its electronic counterpart. The optical correlator is capable of simultaneously resolving multiple targets in both range and doppler, whereas its electronic counterpart requires a complexity of electronics for comparable performance in only one dimension. The modification of the electro-optical light modulator for use as a completely flexible doppler mask, adds a new dimension of flexibility to a device heretofore dependent upon photographic masks. Limitations of optical filtering and doppler mask configuration are presented, as well as the associated electronics. Author (TAB)

N67-35405# Auburn Univ., Ala. Antenna Study Group.
STUDY OF CIRCULAR ARRAYS OF RADIAL AND TANGENTIAL DIPOLES, PART I
C. H. Holmes and J. L. Hilburn 1 Mar. 1967 204 p refs
(Contract AF 19(628)-4991)
(AFCRL-67-0206; SR-1; AD-654682)

The elements of the circular antenna arrays investigated in this study consist of N identical center-fed cylindrical dipoles whose centers are equally spaced around the circumference of a circle. This study first presents the derivation of the integral equations defining the vector potential over the surfaces of the elements. The reduction of these equations to a single integral equation is then obtained by the introduction of sequence voltages for the terminal voltages. A numerical solution of this equation for each sequence is then developed employing the Gaussian quadrature formula for numerical integration. These solutions yield the sequence currents for sequence terminal voltages of unit magnitudes. The sequence patterns are then obtained utilizing the predetermined sequence currents. The FORTRAN IV computer program developed for the computation of these currents and patterns is listed in the Appendices. Finally, an experimental investigation is discussed for the measurement of the current distribution on a driven monopole in a tangential array positioned on a groundplane. Included in this

discussion are detailed drawings of the experimental apparatus constructed for these measurements. The results of this investigation are then compared with the results of the theoretical investigation. Author (TAB)

N67-35419# Harvard Univ., Cambridge, Mass. Gordon McKay Lab.
ON TWO ARBITRARILY LOCATED IDENTICAL PARALLEL ANTENNAS
V. W. H. Chang Mar. 1967 87 p refs
(Contract AF 19(628)-2406; Grant NSF GK-273)
(AFCRL-67-0260; SR-15; AD-655078)

The simultaneous integral equations for two arbitrarily located parallel antennas are first decoupled into two independent integral equations and then each is solved by two different methods: A five-term current approximation method and a conventional numerical method. In the five-term method, the current is represented by five trigonometric functions, three for symmetric(even) and two for antisymmetric(odd) currents. Typical current distributions and input admittances are obtained for half-wave and full-wave antennas in nonstaggered, in 45 degree echelon and in collinear arrangements. For the nonstaggered case, the results predicted by the two methods agree with each other and with experimental data. For the other two arrangements, no experimental data are yet available. However, the two theoretical methods agree quite well. The five-term method will be extended to a general array of N parallel elements in another report. Author (TAB)

N67-35449# Rydbeck Research Associates, Fjaras (Sweden).
TRANSIENT WAVE PROPAGATION IN INHOMOGENEOUS IONIZED MEDIA
B. O. Roennaeng Aug. 1966 87 p refs
(Contract AF 61(052)-864)
(AFCRL-66-843; SR-6; AD-654323)

Transient wave responses of two different inhomogeneous ionized media - the exponential medium and the symmetrical Epstein layer - are studied. By means of the linearized wave equations exact expressions for the unit step wave responses are derived. In both cases they can be written in closed mathematical forms, namely as a Bessel function and a Legendre function respectively. The unit step modulated carrier responses, written as convolution integrals, are computed at different heights in the media and at different carrier frequencies, i.e. the variations of the electric field, the magnetic field and the energy flow are determined. This makes it possible to compare the exact signal envelopes with the earlier obtained approximate results. Futhermore the strong signal distortion at tunnel transmission through a thin symmetrical Epstein layer is studied in detail. Author (TAB)

N67-35462*# Ohio State Univ., Columbus. ElectroScience Lab.
OSU LUNAR DOPPLER EXPERIMENT
W. H. Peake, R. H. Turpin, and R. C. Taylor 1 Aug. 1967 77 p refs
(Grant NsG-213-61)
(NASA-CR-88012; Rept.-1388-22) CSCL 17B

Linear polarized, S-band CW radar signals were reflected from the moon's surface to study Doppler effects due to the apparent libration, or rotation, of the moon. Transmitter, receiver, and recording equipment are described. Digitized data samples obtained were analyzed to determine scattering function, total cross section, dielectric constant, and effective rms slope. These data were compared with experimental results of other investigators and with recent theoretical interpretations. Experimental results show that the apparent lunar rms surface slope at a wavelength of 13.2 cm is about 15°; the lunar radar cross section is about 6% for direct polarization and about 0.4% for cross polarization (±3 dB); and the average dielectric constant of the moon's surface is $\epsilon \approx 2.6$. Comparison of experimental and theoretical backscattering function data indicates that the modified Bessel joint probability function is a more accurate model of the lunar surface than Gaussian joint probability function. Solution of an integral equation for the lunar scattering function and Scatran computer programs used in the data analysis are given. E.C.

N67-35529*# RAND Corp., Santa Monica, Calif.
TRANSIONOSPHERIC PROPAGATION OF FM SIGNALS
E. Bedrosian Aug. 1967 48 p refs
(Contract NASr-21)
(NASA-CR-88084; RM-5379-NASA) CFSTI: HC $3.00/MF $0.65 CSCL 17B

Two cases are examined numerically to illustrate the use of the results. The first case typifies a high-capacity communication link of the Intelsat variety, and it is seen that a significant degradation can occur only under the most unusual conditions. The second example considers a wide-band TV transmission near the upper end of the UHF TV band; in this case, ratios of signal-to-distortion and to cross-talk of about 20 db result. Ratios of this order are clearly cause for concern, but it is not possible to assess their subjective effect by relating them to the familiar interference produced by thermal noise which is uncorrelated with the signal. Also, a TV signal, particularly if color, is not as well modeled by a gaussian signal as is a typical multichannel telephone baseband. For these reasons, it is concluded that an experimental investigation would be desirable both to verify the theory and to develop subjective interference criteria. Author

N67-35599*# National Aeronautics and Space Administration. Electronics Research Center, Cambridge, Mass.
ABSOLUTE TEMPERATURE MEASUREMENT AT MICROWAVE FREQUENCIES
George G. Haroules and Wilfred E. Brown, III Washington, NASA, Sep. 1967 36 p
(NASA-TR-R-271) CFSTI: HC $3.00/MF $0.65 CSCL 09F

A technique is described in which two Dicke-type radiometers are used for absolute temperature measurements at microwave frequencies. The measurement system that has been developed establishes the rf zero of the radiometer and determines the absolute temperature while operating in a rf-balanced condition. A simplified laboratory calibration of the device and the effect of gain stability on measurement accuracy, while observing temperatures near absolute zero, are discussed. Field measurements of sky temperature using standard gain horns and a 28-foot parabolic antenna were conducted at frequencies of 8 and 15 gHz. The experimental results of the program are compared with theoretical predictions of sky temperature for various atmospheric opacities. Author

N67-35602# Ohio State Univ., Columbus. ElectroScience Lab.
ELECTRONICALLY POLARIZED MICROWAVE ANTENNAS Final Technical Report
13 Jul. 1967 11 p refs
(Contract N0019-67-C-0063)
(Rept.-2187-1; AD-655115)

A summary is given of research on the effects of polarization on radome-induced boresight error. Results from a first-order (approximate) theory for the boresight error have been compared with available measurements. In order to determine the influence of radome reflections on boresight performance of array antennas, an analysis was developed for coupling in three-element arrays of parallel plate waveguides. Author (TAB)

N67-35638# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
DETECTION OF PULSE SIGNALS BY DIGITAL STORAGE UNITS

N. F. Klyuyev 14 Apr. 1967 97 p refs Transl. into ENGLISH of the book "Obnaruzheniye Impul'snykh Signalov s Pomoshch'yu Nakopiteley Diskretnogo Deystviya" Moscow, Izd. "Sovetskogo Radio", 1963 p 1–111
(FTD-MT-65-198; TT-67-62290; AD-655037)

The book is devoted to research published in the periodical press on the use of digital accumulators in the detection of repeated pulse signals in noise. The book also contains the results of research by the author in this area. The problems are considered on the basis of statistical methods with main attention devoted to evaluation of the effectiveness of these methods with respect to the detection threshold. A large part of the book deals with problems of synthesizing optimal programs for processing signals by digital methods. The book is intended for persons interested in the problems of automatic selection of signals in noise. It can also be useful for graduate students and students specializing in radar. Author (TAB)

N67-35655# Illinois Univ., Urbana. Biological Computer Lab.
UNCERTAINTY ANALYSIS IN DYNAMIC SYSTEMS
Stephen G. Powers 15 May 1967 39 p refs
(Contract AF 33(615)-3890; Grant AF-AFOSR-7-67)
(BCL-8.0; AFOSR-67-1413; AD-654310) CFSTI: HC $3.00/MF $0.65

The total constraint of a dynamic system is analyzed in terms of the cause-effect relationship between parts of the system. The cause-effect relationships are represented qualitatively on Ashby diagrams of immediate effects (DIE) (Introduction to Cybernetics) and on diagrams of K effects for systems over k time intervals. (Construction of the DIE requires either knowledge of the mapping of every variable of the system and the mapping joining them, or the ability to force the system into all possible system states). Systems of 2, 3, and n variables are considered. Preliminarily, techniques are presented that facilitate analysis by allowing selection or creation of information relations of the desired form from a modest catalog of the most general and useful relations. Proofs are given for the reformulations. TAB

N67-35656# Naval Research Lab., Washington, D. C.
AN/FPQ-6 RADAR ANTENNA GAIN DETERMINATION BY PATTERN INTEGRATION TECHNIQUES Interim Report
Dean D. Howard 23 Jun. 1967 25 p ref
(NRL-MR-1784; AD-654925) CFSTI: HC $3.00/MF $0.65

The acceptance test gain determination for the 29 foot diameter Cassegrainian antenna of the AN/FPQ-6 radar was performed by antenna pattern integration techniques. This approach was used because of time limitations and difficulties of setting up an accurate boresight range for conventional gain comparison with a gain standard. By pattern integration of both the antenna and the feed patterns, the effective loss of near-in sidelobes and the spillover around the Cassegrainian sub-reflector could be determined separately with good accuracy. This approach gives considerable information on several characteristics of the antenna which led, in part, to changes for improving antenna performance. The less significant losses were estimated. The resultant gain determined by this technique averaged at 51.1-db over the band. This was confirmed at a later evaluation program where direct measurement gave an average gain of 51.2-db over the band. Author (TAB)

N67-35663# Federal Aviation Agency, Atlantic City, N. J. Dept. of Transportation.
TEST AND EVALUATION OF THE RADAR VIDEO DATA PROCESSOR Final Report
Albert A. Lupinetti and Roy P. Schindler Jun. 1967 186 p refs
(NS-67-1)

The radar video data processor (RVDP) processes primary and secondary raw radar information inputs to derive aircraft position and to extract identity and altitude code information. The processed data are in digital format and are remoted over narrow-band telephone lines. Detailed tests of the RVDP detection criteria did not reveal any unexplainable deviations from detection theory. The on-line tests indicated that system sensitivity and track-thru-clutter capability compared favorably with unprocessed radar data remoted by conventional wide-band systems. In the course of the test program certain modifications were incorporated into the RVDP, and at the conclusion of the test program other modifications were recommended. It is concluded that the RVDP represents a suitable design approach for the reliable detection and processing of primary and secondary radar information for the National Airspace System. Author

N67-35669# MITRE Corp., Bedford, Mass.
STUDIES IN DISPLAY SYMBOL LEGIBILITY. PART XVII: THE LEGIBILITY OF THE LINCOLN/MITRE FONT ON TELEVISION
Donald Shurtleff Apr. 1967 28 p refs
(Contract AF 19(628)-5165)
(MTR-389; ESD-TR-67-105; AD-654670)

The legibility of standard Leroy alphanumeric symbols was compared with that of a new font, the Lincoln/MITRE, on a television monitor at resolutions of 8, 10, 12 and 14 lines per symbol height. The new font was not superior in legibility to the Leroy font at any of the values of resolution tested. While the findings for the new font were negative, insights were gained about how to improve symbol design for more legible television displays. It was recommended that these new design techniques be evaluated in future work on television displays. Author (TAB)

N67-35704# Naval Research Lab., Washington, D. C.
A NOTE ON THE POLARIZATION AND PHASE CHARACTERISTICS OF RADIO WAVES PROPAGATING THROUGH THE LOWER IONOSPHERE Final Report
John M. Goodman 5 Jun. 1967 44 p refs
(NRL-6532; AD-654707)

Some ionospheric radio propagation problems associated with the satellite radar situation have been examined for radar frequencies between 100 and 1000 Mc/s. It has been shown that the maximum number of fades exhibited by a train of radar pulses is governed by the quantity H csc I, where H is the magnetic field intensity and I is the magnetic field inclination, except near the magnetic equator. At 100 Mc/s the maximum number of fades is characteristically less than 50, and since the Faraday rotation is inversely proportional to the square of the radar frequency, only one-half of a fade should be observed at 1000 Mc/s. Faraday rotational signal degradation of a linearly polarized radar signal has been shown to be negligible at 1000 Mc/s except possibly during winter days at sunspot maximum. In all but possibly the polar region, it is suggested that the relationship between irregularity scale Delta L and phase excursion Delta delta is given by Delta L/Delta delta (n sub f) approximately equal to 1000, where Delta L is in meters, Delta delta is in radians, and n sub f is the radar frequency in hundreds of megacycles per second. Author (TAB)

N67-35707# Sperry Gyroscope Co., Great Neck, N. Y.
MICROWAVE ALL-PASS NETWORKS FOR ANTENNA FEED SYSTEMS Interim Scientific Report
Lowell I. Smilen 15 Jan. 1967 71 p refs
(Contract AF 19(628)-5743)
(AFCRL-67-0235; SR-1; AD-654680)

The report presents a comprehensive theory for the development of distributed feed systems for use with reflector antennas. The feed systems which are generated consist of linear, lossless, multiport networks used in conjunction with an array of small radiators that is distributed transversely in the focal regions of the antennas. The first part of the report is devoted to the analysis and synthesis of reciprocal, lossless, all-pass 2n-port networks. Several new members of this class of networks are described. The second part deals with the application of these

networks to the problem of approximating families of electric field distributions in the focal regions of reflector antennas.
Author (TAB)

N67-35715# Bitterlich (Wolfram), Innsbruck (Austria).
PROPAGATION OF LONG ELECTROMAGNETIC WAVES THROUGH ROCK Scientific Report, 1 Feb. 1965–1 Feb. 1967
N. Nessler 15 Apr. 1967 64 p refs
(Contract AF 61(052)-902)
(AFCRL-67-0361; SR-2; AD-654694)

A description is given of the propagation of long electromagnetic waves through rock, in continuation of previous studies on the VLF region. The theoretical bases of wave propagation are reviewed. Important results of comprehensive calculations are summarized and methods of measuring the propagation parameters, dielectric constant, and conductivity, are derived. The instruments used for conducting the measurements are described. Measurements in the near field and in the near field - far field transition zone as well as through ore beds are evaluated. Author (TAB)

N67-35719# Hawaii Univ., Honolulu. Dept. of Electrical Engineering.
LONG BCH CODES ARE BAD
S. Lin and E. J. Weldon, Jr. 15 Feb. 1967 17 p refs
(Contract AF 19(628)-4379)
(AFCRL-67-0179; SR-14; AD-654676)

Of the numerous classes of random-error-correcting codes proposed to date, the class discovered by Bose and Chaudhuri (1960) and, independently and earlier by Hocquenghem (1959) are easily the most widely renowned. However, it has been observed that the BCH bound approaches zero with increasing code length for any fixed value of the ratio of minimum distance to code length. This paper shows that it is the codes, and not the bound, which deteriorate with increasing code length. TAB

N67-35734*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
INPUT ADMITTANCE OF A COAXIAL TRANSMISSION LINE OPENING ON TO A FLAT, DIELECTRIC-COVERED GROUND PLANE
Calvin T. Swift Washington, NASA, Sep. 1967 33 p refs
(NASA-TN-D-4158) CFSTI: HC $3.00/MF $0.65 CSCL 09F

The input admittance of a coaxial transmission line opening onto a flat, dielectric-covered ground plane is derived, and computational results are given as a function of slab thickness in wavelengths. A dielectric constant of 2.57 was selected for the slab, which physically corresponds to that for lucite or polystyrene. Surface wave contributions are considered in the calculations, and the results show that over some ranges of slab thickness 90 percent of the power supplied to the antenna is trapped in the dielectric. Comments pertinent to a physically realizable antenna are included. Author

N67-35779*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
A TURNSTILE CONICAL-SCAN FEED TO IMPROVE TRACKING-ANTENNA PERFORMANCE OF APOLLO-INSTRUMENTED SHIPS
Paul A. Lantz Aug. 1967 40 p
(NASA-TM-X-55899; X-525-67-322) CFSTI: HC $3.00/MF $0.65 CSCL 09F

The design, development, and fabrication of a turnstile for use as a conical scanning feed in a 30-foot paraboloidal reflector is described. On the Apollo-instrumented ships telemetry tracking antenna, this feed will replace a balanced conical logarithmic spiral now operating over the wide band from 225 to 2300 MHz. The turnstile operates over the narrow frequency band from 225 to 260 MHz and provides both senses of circular polarization simultaneously, resulting in superior performance over the narrower frequency band. It was necessary to remove a cavity backing the turnstile, because of excessive drag on the drive unit. Some compromise in primary pattern directivity resulted; however, performance is superior to that of the existing feed. Mechanical design characteristics permit direct replacement provided that the feed assembly is refocused. Author

N67-35817# Joint Publications Research Service, Washington, D. C.
THE CONSTRUCTION OF THE DISTRIBUTION FUNCTION WITH RESPECT TO OBSERVATIONS IN PATTERN RECOGNITION PROBLEMS
A. Ya. Burinskiy *In its* Tech. Cybernetics, No. 3, 1967 21 Aug. 1967 p 166–175 refs (See N67-35801 21-10)

The construction of the optimal decision rule is considered in the problem of pattern recognition. An effort is made to extend optimization to the training process which is connected with optimization of the construction of the distribution functions. The class of all possible distribution functions is written in parametric form which permits carryover of the a priori difficulty to the value of the parameter. One procedure for parameterization of a broad class of distribution functions is investigated. The optimal distribution function and the optimal decision rule are found in the pattern recognition problem after training with illustrations. Author

N67-35823# Joint Publications Research Service, Washington, D. C.
THE CHARACTERISTICS OF SPATIAL FILTRATION OF SOME TYPES OF ELECTRONIC–OPTICAL DIRECTION-FINDER SCANNERS
V. L. Levshin *In its* Tech. Cybernetics, No. 3, 1967 21 Aug. 1967 p 220–237 refs (See N67-35801 21-10)

An investigation was conducted on the problems of separation of a signal from a small emitting object against a correlated interference background, using electronic–optical direction finder scanners of several types. The allowable values are defined for the signal/noise ratio at the output of the linear part consisting of a focusing lens, a single or multi-element pattern analyzer which scans in a circle or epicycloid, and an amplifying channel. The characteristics of the useful signal, the random interference signal from the background, and the resultant signal/noise ratios are investigated. Author

N67-35824# Joint Publications Research Service, Washington, D. C.
MATHEMATICAL MODELS OF MULTICHANNEL RADIO ENGINEERING DEVICES UNDER THE EFFECT OF RADIO NOISE
M. V. Maksimov *In its* Tech. Cybernetics, No. 3, 1967 21 Aug. 1967 p 238–247 (See N67-35801 21-10)

A solution is presented to the problem of mathematical models for multichannel radio engineering devices. These are defined as command and control radio channels (remote control radio channels), and the discrimination receiver parts of the coordinate meters. Also considered is the fact that the interchannel communications are under the influence of radio noise, and the conversion parameters of these devices vary with respect to the transmitted commands and error signals. A method for defining mathematical models for radio engineering devices, affected by signals and noise, is developed further. Author

N67-35826# Joint Publications Research Service, Washington, D. C.
SEQUENTIAL DECODING OPTIMAL WITH RESPECT TO ERROR PROBABILITY
V. A. Morozov *In its* Tech. Cybernetics, No. 3, 1967 21 Aug. 1967 p 248–254 refs (See N67-35801 21-10)

Details are given on modifying the procedure of sequential Ziv decoding for which dependency of the average error probability on the code restriction n_t is approximately correct as for optimal decoding (with respect to the similarity maximum). The average number of calculations for decoding of one information symbol in this procedure is restricted from above by a power function n_t for a transmission rate of $R<(1/2)R_{out}$. Author

N67-35827# Joint Publications Research Service, Washington, D. C.
IDENTIFICATION OF A CLASS OF NONLINEAR OBJECTS
M. M. Makarchuk *In its* Tech. Cybernetics, No. 3, 1967 21 Aug. 1967 p 265–275 refs (See N67-35801 21-10)

A procedure is proposed for defining models of unknown nonlinear nonstationary objects having a finite value of the mathematical expectancy of the square of the output signal at any point in time when a signal of the white noise type is fed to the input of the objects. The accuracy of the model obtained is estimated. Author

N67-35828# Joint Publications Research Service, Washington, D. C.
DEFINITION OF MULTIDIMENSIONAL OPTIMAL SYSTEMS WITH A NONLINEAR COMBINATION OF USEFUL SIGNAL AND NOISE
L. G. Yevlanov *In its* Tech. Cybernetics, No. 3, 1967 21 Aug. 1967 p 276–285 refs (See N67-35801 21-10)

Multidimensional optimal systems for separation and detection of useful signals, depending on a finite number of random parameters and observable in nonlinear combination with noise, is investigated. For the case where the observable vector of the input signal with a fixed value of the vector of the parameters of the useful signal is a Gaussian random process, the *a posteriori* probability density of the vector of the parameters is calculated. Using this *a posteriori* probability density, it is possible to define the optimal systems with respect to various criteria of the Bayes type. The result obtained includes as special cases the solutions of known problems of determination of optimal systems with additive and multiplicative noise. Author

N67-35831# Joint Publications Research Service, Washington, D. C.
DEFINITION OF A CORRELATION ERROR MATRIX WHEN EVALUATING A SET OF PARAMETERS
S. P. Dmitriyev *In its* Tech. Cybernetics, No. 3, 1967 21 Aug. 1967 p 312–316 refs (See N67-35801 21-10)

Consideration is given to the case of evaluating the vector parameter when measuring a signal representing a linear combination of given time functions with random coefficients distorted by white noise. It is demonstrated that the correlation error matrix for the measurements coincides with the matrix of coefficients defined when finding the optimal weight function. Author

N67-35885# Lincoln Lab., Mass. Inst. of Tech., Lexington.
AN APPROACH TO TARGET TRACKING
Michael Gruber 10 Feb. 1967 39 p refs
(Contract AF 19(628)-5167; ARPA Order 498)
(TN-1967-8; ESD-TR-67-161; AD-654272)

The report presents an approach to point target tracking based on sequential filtering techniques. The tracking problem is defined in terms of a nonlinear vector differential equation and an appropriate state vector. A Bayesian formulation for the problem is selected which results in a least-squares filter solution. Linearization techniques essential to this approach are incorporated into the development of the solution. A computer program which implements the complete solution algorithm is presented. As part of this computer realization, numerical integration of the equations of motion and numerical evolution of the estimate covariance matrix are discussed in detail. Author (TAB)

N67-35887# White Sands Missile Range, N. Mex.
A MATH MODEL FOR COMPUTING NOISE VARIANCE MATRICES FOR A SYSTEM OF RADAR TRACKERS
James S. Pappas and Alfonso Diaz Jul. 1967 83 p refs
(RO-S-67-2; AD-654986)

The paper presents a method of calibrating (noisy) sensors using an unweighted least-squares procedure in a vector space setting and using orthogonal projections to implement the least-squares criterion. Using the least-squares estimate of the parameters that characterize the sensors, a variance matrix of the noise on each sensor is then computed. The method is illustrated by an analysis of both a scalar process (e.g., output of amplifiers) and a multi-variable process (e.g., output of amplifiers) and a multi-variable process (e.g., radars tracking an object). The scheme, it should be pointed out, is independent of the inputs to the system under study and hence provides a powerful tool for analysis. Finally, derivations are made in a vector-space setting employing vector-matrix techniques and using an adapted version of the notation of Dirac and Friedman. The topics covered include such items as linear transformations, vector spaces, vector packaging, variance analysis of vector (multi-variable) processes, least squares via orthogonal projections, and others. Author (TAB)

N67-35915* Purdue Univ., Lafayette, Ind. School of Electrical Engineering.
RANDOM SIGNAL RADAR Final Report
G. R. Cooper and C. D. McGillem Jun. 1967 165 p refs
(Grant NsG-543)
(NASA-CR-88209; PRF-4696; TR-EE67-11) CSCL 17I

Theoretical and experimental data are presented to demonstrate the feasibility of obtaining substantially improved radar performance by using a random signal as the transmitted waveform. Basic concepts of the random signal radar are discussed, and the fundamental equations are derived. A mathematical analysis is conducted on the wideband polarity coincidence digital cross correlator which was developed for use as the detector in such a system. This correlator measures the polarity of short samples of the transmitted and received waveforms, and preserves the range and Doppler resolution capabilities of the waveforms while operating at a data rate that is only a small fraction of the signal bandwidth. The experimental system provided a range resolution of 1.2 meters while operating with a RF bandwidth of 109 MHz and a correlator sampling frequency of 100 kHz. Theoretical results on target impulse responses are given for use in interpreting radar return signals for all types of systems. Applications of the random signal radar were studied, and performance beyond that of conventional radars appears feasible in many instances. M.G.J.

N67-35916*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
A COMPARISON OF DECISION SYSTEMS WITH DATA REJECTION
J. C. Morakis Jul. 1967 22 p refs
(NASA-TM-X-55900; X-520-67-360) CFSTI: HC $3.00/MF $0.65
CSCL 09D

The advent of convolutional codes provides us with extremely low error rates at the expense of data rejection. These codes are compared to a perfect code and to a decision system capable of variable deletion rates. The deletion rates can be adjusted to values equal to those of convolutional codes resulting thus in a fair comparison. Author

N67-35964# Smithsonian Astrophysical Observatory, Cambridge, Mass.
DATA REDUCTION

R. Haefner and R. Martin *In its* Geodetic Parameters for a 1966 Smithsonian Inst. Std. Earth, Vol. 1 1966 p 43–61 refs (See N67-35962 21-13)

Scientific instruments for data reduction of field observations for weather prediction are described. The camera and tracking system include a Baker–Nunn network capable of tracking from 0° to 2° sec^{-1} and of photographing satellites of the 12th magnitude. The maintenance of timing records are outlined in the precise reduction of field observations. Tabular data provide propagation times in seconds, by station and number, for various time references. All satellite positions are given within the reference frame of the SAO Star Catalog. R.U.

N67-35965# Smithsonian Astrophysical Observatory, Cambridge, Mass.

GEOMETRICAL METHODS

L. Aardoom, A. Girnius, and George Veis *In its* Geodetic Parameters for a 1966 Smithsonian Inst. Std. Earth, Vol. 1 1966 p 63–75 refs (See N67-35962 21-13)

Geometric methods used in astrophysical observations are briefly outlined. The Baker–Nunn cameras for simultaneous observations within 1 or 2 msec indicate satellite transits. Concepts of data reduction direction determination, and coplanar condition are also provided. R.U.

N67-35968# Smithsonian Astrophysical Observatory, Cambridge, Mass.

DETERMINATION OF ZONAL HARMONIC COEFFICIENTS

Y. Kozai *In its* Geodetic Parameters for a 1966 Smithsonian Inst. Std. Earth, Vol. 1 1966 p 191–194 refs (See N67-35962 21-13)

Baker–Nunn cameras were used for observations in determining zonal harmonic coefficients. The mean orbital elements of each satellite for every 2 or 4 days were obtained from observations covering 4 or 8 days. Lunisolar-periodic and solar-radiation perturbations in the orbital elements were then computed and subtracted from the mean orbital elements. To derive secular motions of the ascending node and the perigee and amplitudes of long-periodic terms from these orbital elements, data were used which covered one period of revolution of augment of perigee, or about 80 days for Vanguard satellites, for example. A comprehensive mathematical description is developed. R.U.

N67-35969# Smithsonian Astrophysical Observatory, Cambridge, Mass.

DETERMINATION OF TESSERAL HARMONIC COEFFICIENTS AND STATION COORDINATES

Imre G. Izsak and E. M. Gaposchkin *In its* Geodetic Parameters for a 1966 Smithsonian Inst. Std. Earth, Vol. 1 1966 p 195–205 refs (See N67-35962 21-13)

Tesseral harmonics in the external gravitational field of the earth are considered. Experimental evidence shows that the correlations among harmonic coefficients and station coordinates are generally weak, and that those among corrections to the coordinates of different stations are entirely negligible. Since the original connection of the observation stations to major geodetic systems proved to be unreliable in several instances, the 12 satellite tracking stations were treated individually. A detailed computation of satellite orbits is provided. The effect of the tesseral harmonics in the geopotential, and the effect of small errors in the adopted station coordinates are also mentioned. R.U.

N67-35970# Smithsonian Astrophysical Observatory, Cambridge, Mass.

COMBINATION OF GEOMETRIC AND DYNAMIC METHODS

W. Koehnlein *In its* Geodetic Parameters for a 1966 Smithsonian Inst. Std. Earth, Vol. 1 1966 p 207–221 refs (See N67-35962 21-13)

Absolute space directions as obtained from camera observations of artificial satellites against the star background are used in methods for determining station positions. Weighting, combination geometric and dynamic methods in computations, space triangulation, and orientation errors are discussed in mathematical terms. The dynamic method results in absolute station positions referred to the mass center of the earth, while simultaneously solving also for the nonzonal harmonic coefficients of the earth's gravitational field; the scale is introduced in the latter by the geocentric gravitational constant. A characteristic of the geometric method is the high accuracy achieved in the determination of relative station positions. R.U.

N67-36037 Radio and Space Research Station, Slough (England).

OPTICAL OBSERVATIONS OF SATELLITES RECEIVED BY THE SATELLITE ORBITS GROUP FOR THE MONTH OF MARCH 1967

Mar. 1967 55 p

Tabulated data on satellites observed by the Satellites Orbits Group of England during March 1967 are presented. R.N.A.

N67-36062 Radio and Space Research Station, Slough (England).

KINETHEODOLITE OBSERVATIONS OF SATELLITES RECEIVED BY THE SATELLITE ORBITS GROUP FROM MALTA FOR AUGUST 1966, PART 1

1966 53 p *Its* Issue No. 30

Kinetheodolite observations of the satellites: Midas 4 (1961 28A); Ariel 1 (1962 15A); Star-Rad (1962 58A); Thor Agena D (1963 03A); Dash 2 (1963 30 D); Polyot 1 (1963 43 A); Explorer 19 (1963 53A); Ariel 2 Rocket (1964 15B); Nimbus 1 Rocket (1964 52 B); and Explorer 24 (1964 76 A), made during August 1966 from Malta are presented. L.S.

N67-36102*# Hughes Aircraft Co., Culver City, Calif. Antenna Dept.

STUDY OF APPLICATIONS OF RETRODIRECTIVE AND SELF-ADAPTIVE ELECTROMAGNETIC WAVE PHASE CONTROLS TO A MARS PROBE Final Report, 8 Nov. 1965–8 Oct. 1966

A. T. Villeneuve, J. E. Howard, G. O. Young, and A. A. Ksienski 8 Oct. 1966 162 p refs

(Contract NAS2-3297)

(NASA-CR-73118; P67-153) CSCL 09F

Arrays were analyzed that obtain self-steering by the use of either phase-locked loops or phase inversion by mixing. The effectiveness of each type in receiving signals with various digital modulations was analyzed, and the probability of error of each type in detecting signals of each modulation in the presence of random gaussian phase errors was determined. Signal-to-noise ratios of each type were compared. System calculations were performed for a phase-inversion system operating over 4000 and 12,000-mile links. Signal-to-noise values were obtained from which probabilities of error can be determined. Author

N67-36141# Radio Corp. of America, New York. CSD Advanced Communications Technology Lab.

SIGNAL ENHANCEMENT TECHNIQUES Final Report, 1 May 1966–30 Apr. 1967

B. Bossard, E. Markard, S. Perlow, and P. Torrione Jul. 1967 29 p ref

(Contract DA-28-043-AMC-02280(E))

(Rept.-4; ECOM-02280-F; AD-654515)

The design and construction of a broadband voltage-tunable receiver is discussed. The receiver is designed with a high-dynamic range and extremely low-noise resistive mixer. The possibility of

the use of cooled resistive mixers for ultralow-noise, high-dynamic range receiver is discussed and experimental results are presented. An approach to low distortion, low-noise frequency converters is presented. A variable gamma varactor upconverter is evaluated theoretically and experimental results are presented. A method is presented by which it is possible to eliminate or reduce the effects of a large undesired signal whose sidebands partially overlap a smaller desired signal. Author (TAB)

N67-36151# Weapons Research Establishment, Salisbury (Australia).
AN INVESTIGATION OF A 1/8 SCALE MODEL OF AN 86 FT. DIAMETER DUAL FREQUENCY ANTENNA
C. T. Carson, J. Ellershaw, and A. Tickner Sep. 1965 54 p
(WRE-TN-PAD-107)

Tests on a 1/8 scale model of an 86 ft diameter parabolic antenna operating at 55 Mc/s and 153 Mc/s are described. It is shown that the performance of the antenna at 153 Mc/s is deteriorated by interaction between the 55 Mc/s and 153 Mc/s feeds. Author

N67-36182# Hawaii Univ., Honolulu. Dept. of Electrical Engineering.
NON-PRIMITIVE REED-MULLER CODES
E. J. Weldon, Jr. 15 Feb. 1967 25 p refs
(Contract AF 19(628)-4379)
(AFCRL-67-0177; SR-12; AD-654674)

A new class of random-error-correcting codes is presented. These codes are called non-primitive Reed-Muller codes because of their close relationship to the (primitive) Reed-Muller codes. It is shown that the class of non-primitive Reed-Muller codes contains the projective geometry codes discovered by Rudolph as a subclass. These latter codes are investigated in detail and two results proved. First, the codes are moderately efficient random-error-correctors for practical values of code length and rate. Second, they can be decoded with a relatively modest amount of equipment. As such it appears that these codes may be suitable for use in error control systems requiring random-error correction. TAB

N67-36283 Joint Publications Research Service, Washington, D. C.
THE USE OF COMMUNICATION SATELLITES FOR TRANSMISSION OF UNIDIRECTIONAL (SIMPLEX) PROGRAMS
N. V. Talyzin and L. Ya. Kantor 11 Aug. 1967 10 p refs Transl. into ENGLISH from Radiotekhn. (Moscow), no. 6, Jun. 1967 p 1–7
(JPRS-42194; TT-67-32824) CFSTI: HC $3.00

Considered are the basic technical and economic parameters in a system for unidirectional transmission of information with the aid of communication satellites. The effectiveness of such a system is demonstrated. Author

N67-36408# Harvard Univ., Cambridge, Mass. Cruft Lab.
A COMPARISON BETWEEN A N-ELEMENTS CIRCULAR ARRAY AND AN ELECTRICALLY THICK TUBULAR DIPOLE ANTENNA WITH EQUIVALENT RADIUS
David C. Chang Mar. 1967 42 p refs
(Contract AF 19(628)-2406; Grant NSF GK-273)
(SR-16, Ser. 3; AFCRL-67-0258; AD-655079)

A comparison is made on the properties of an equally-spaced, identically-driven N-elements circular array with a circumference less than a free space wavelength, and an electrically thick tubular dipole antenna with a radius equal to that of the array. In the case of an array with infinite long elements, it is found that two current distributions differ from each other only by a term which is in the order of 1/N Log N. In the case of an array with elements of finite length, a modified Kings three term theory has been applied and compared with the numerical solution of an electrically thick tubular dipole antenna. Author (TAB)

N67-36421* New Mexico Univ., Albuquerque. Bureau of Engineering Research.
A BISTATIC RADAR METHOD FOR THE DETERMINATION OF ϵ AND μ FOR A SMOOTH SPHERICAL TARGET
A. Erteza and J. A. Doran [1967] 28 p refs
(Grant NsG-129-61)
(NASA-CR-88082) CSCL 17H

A method is presented for determining the permeability and permittivity of the material composing a smooth reflecting sphere. It is based on relative scattered-power measurements in a bistatic radar or optical experiment. Absolute power measurements are not necessary; only the ratio of the powers received by two quadratically opposed antennas is needed. This ratio is determined for two different configurations of source, target, and observation point. Theoretical derivation of the method is based on the concept of differential reflectivity which requires that the radius to wavelength ratio be large. Author

N67-36452# Hawaii Univ., Honolulu. Dept. of Electrical Engineering.
ON SEQUENTIAL DECODING
S. Lin 7 Feb. 1967 51 p refs
(Contract AF 19(628)-4379)
(AFCRL-67-0176; SR-11; AD-654673)

By a proper selection of distance metric, it is possible to show that the average number of computations for the Wozencraft sequential decoding algorithm can be bounded independently of the code constraint length for transmission rates below a computation rate Rcomp. The bound on the probability of decoding error is proved to be similar to the bound for Fanos algorithm. A modification of the Wozencraft algorithm is presented. Use of a multiple-threshold test (MTT) enables the decoder to adjust its operation to the noise conditions. A modified search procedure is also presented. Analytical results show that this modified algorithm is comparable with Fanos algorithm in terms of the average number of computations and the probability of error. Author (TAB)

N67-36455 Library of Congress, Washington, D. C.
TRACKING OF MISSILES AND SPACE VEHICLES Surveys of Foreign Scientific and Technical Literature, Aug. 1966–Mar. 1967
Stuart Hibben 1 Sep. 1967 40 p refs
(ATD-67-45; Rept.-27)

Soviet open literature sources are surveyed, for the period covering August 1966 through March 1967, and abstracts are presented for the subject areas of tracking equipment, baseline establishment, frequency measurement, and radio astronomy. There are also included brief summaries of five papers delivered at the May 1966 COSPAR meeting in Vienna; these articles have not otherwise been published in the formal literature. R.U.

N67-36531 Sud-Aviation, Cannes (France).
EXPLOITATION OF WIND MEASUREMENTS MADE WITH A SOUNDING BALLOON TRACKED BY PRECISION RADAR [EXPLOITATION DES MESURES DE VENT EFFECTUEES A L'AIDE D'UN BALLON SONDE SUIVI PAR UN RADAR DE PRECISION]
A. Mortelette [1965] 23 p refs In FRENCH Presented at the 23rd Congr. of the Sect. "Struct. and Mater." of AGARD

Wind velocity and turbulent motion are calculated and analyzed with the help of a sounding balloon. The radar technique is used to improve accuracy, in an arrangement with numerical values for filters. For statistically significant results, several soundings were required. Transl. by R.U.

N67-36590# Centro Informazioni Studi Esperienze, Milan (Italy).
OPTIMIZATION OF THE SIGNAL-TO-NOISE RATIO IN PRESENCE OF NOISE AND PILE-UP FLUCTUATIONS
C. Bussolati (Politecnico de Milano), I. De Lotto (Bologna Univ.), and E. Gatti Mar. 1967 34 p refs Presented at the Conf. on Semiconductor Nucl. Particle Detectors and Circuits, Gatlinburg, Tenn., 15–18 May 1967
(CISE-107; CONF-670520-1)

The optimization of the signal-to-noise ratio in presence of noise and pile-up fluctuations is examined. A general analysis of the optimum weights for a weighted linear combination of two or three samplings on the input pulse is presented. Some cases of particular interest are then analyzed to evaluate the efficiency of the proposed method of amplitude measurement. Author (NSA)

N67-36606*# Stanford Research Inst., Menlo Park, Calif.
STUDY AND APPLICATIONS OF RETRODIRECTIVE AND SELF-ADAPTIVE ELECTROMAGNETIC WAVE CONTROLS TO A MARS PROBE Quarterly Report, 1 Jan.–31 Jul. 1966
Colin A. Hacking and C. H. Dawson Nov. 1966 51 p refs
(Contract NAS2-2933)
(NASA-CR-73120; QR-3) CFSTI: HC $3.00/MF $0.65 CSCL 09F

The effects on the spectrum of a received or transmitted CW signal associated with one or the other of two antennas each having a generally cylindrical configuration and spinning about its axis is reported. The spectrum associated with a single element on such an antenna is very broad, with high energy content in high-order sidebands. However, the effect of spinning, on the retransmitted spectrum, of a complete retrodirective antenna is shown to be quite small. Author

N67-36611# Stanford Univ., Calif. Radioscience Lab.
BISTATIC-RADAR IMAGING AND MEASUREMENT TECHNIQUES FOR THE STUDY OF PLANETARY SURFACES
George Leonard Tyler, Jr. May 1967 122 p refs
(Grant NsG-377)
(NASA-CR-88284; SEL-67-042; SR-19) CFSTI: HC $3.00/MF $0.65 CSCL 09F

Astronomical bistatic radar theory is investigated. Subject areas treated in detail include: (1) scattering properties of a planet as viewed from a spacecraft; (2) a method for recovering the radar brightness distribution from the scattered wave on the basis of a heuristic method; (3) three physical interpretations of the inversion method; (4) development of the inversion as a maximum likelihood estimator of the brightness distribution from a specified surface area; (5) five methods of realizing the estimator, with realization in terms of two time invariant filters, a time varying filter, and an auto-correlator; and (6) some experimental results from the application of bistatic radar to the surface of a celestial body. An experiment using a lunar orbiter spacecraft is described and samples of the observations are given. A two-dimensional map, made from observation of a reflected, continuous-wave signal, is presented. E.C.

N67-36659 Joint Publications Research Service, Washington, D. C.
DESIGN AND METHODS OF CALCULATING PARAMETERS OF LONG-WAVE AND ULTRA-LONG-WAVE ANTENNAS
11 Aug. 1967 27 p refs Transl. into ENGLISH from Antenny (Moscow), no. 1, 1966 p 1–152
(JPRS-42193; TT-67-32823) CFSTI: $3.00

The problems of a sound design of fixed antennas of the capacitor (cavity) type are examined. It is shown that the basic electrical characteristics of these systems are determined only by the volume occupied by the antenna system and are not dependent on its configuration, a criterion for the selection of which may be the cost of the system. Also given here is the procedure for calculating the basic parameters (capacitance, effective height and loss resistances) in the ground system of an antenna. Author

N67-36665*# Atlantic Research Corp., Alexandria, Va. Jansky and Bailey Systems Engineering Dept.
TECHNICAL AND COST FACTORS THAT EFFECT TELEVISION RECEPTION FROM A SYNCHRONOUS SATELLITE Final Report
30 Jun. 1966 189 p refs
(Contract NASw-1305)
(NASA-CR-76601; TR-PL-9037) CFSTI: HC $3.00/MF $0.65 CSCL 17B

Technical requirements for providing television video of defined grades of quality are specified. All combinations of equipment that provide satisfactory reception are considered. A large range of different values of Effective Radiated Power (ERP) are assumed and a specific determination is made of minimum cost receiving systems parameters for each assumed value of satellite ERP. A separate set of solutions is derived for operation in different parts of the frequency spectrum from 200 Mc/s to 12,000 Mc/s. The results include combinations of receiving station's parameters that range from low cost to expensive receiving installations. Cost and performance information for components which can be provided between now and 1970 provided a requirement is established is given. A computer program using the IBM 360-30 system was used to facilitate determination of a minimum cost receiving system from all possible combinations of receiving system parameters. The rationale used in optimization of system parameters for various values of assumed satellite power and for operation in different parts of the spectrum is explained. L.S.

08 COMPUTERS

Includes computer operation and programming; and data processing. For basic research see: 19 Mathematics.

N67-35326# Stanford Univ., Calif. Operations Research House.
MATHEMATICAL PROGRAMMING LANGUAGE
Paul Pinsky Jun. 1967 23 p
(Contracts DAHC04-67-C-0028; N00014-67-A-0112-0011; N00014-67-A-0112-0016; AT(04-3)-326; Grant NSF GP-6431)
(TR-67-4; AD-654485)

The general objective is to develop a highly readable language for preparing experimental programs for solving large-scale mathematical programming systems. A set of conventions have been tentatively agreed upon. For flexibility a program will be made up from modules consisting of short subroutines. The latter are each translated by a human coder into a standard programming language (such as FORTRAN or ALGOL.) No plans are contemplated at present for a mechanical translator. Author (TAB)

N67-35328# Stanford Research Inst. Menlo Park Calif.
HIGH-INFORMATION-DENSITY STORAGE SURFACES Quarterly Report, 1 Jan.–31 Mar. 1967
Kendal T. Rogers and John Kelly Jun. 1967 29 p ref
(Contract DA-28-043-AMC-01261(E))
(ECOM-01261-8; Rept.-8; QR-8; AD-654517)

This program is now devoted to the preparation and investigation of two novel kinds of electron beam addressable storage elements of about micron size and densely packed arrays of these elements. One kind of element, called a micro-cap, consists of an isolated microcapacitor at the bottom of a hole in a metal-dielectric film sandwich. The other kind, called a micron-ring, consists of an isolated metal film ring embedded concentrically within a hole in

a metal-dielectric film sandwich. During this quarter, storage and readout work on the micro-cap elements was extended to higher beam voltages. It was found that at higher voltages more read passes could be made on the storage array before the binary information was lost. The mildly bakeable (400C) field emitter and molybdenum lens system and its associated commercial ultra-high vacuum system is being assembled for operational tests. Work on storage structures is continuing. A larger (6-micron diameter) version of the micron-ring type of element suitable for initial tests has been produced and awaits testing. Other methods of producing submicron micron-ring elements are being examined. The electron microscope, which has been converted into a scanning probe for exposure of electron resist, is working satisfactorily, and it should be possible to produce 1/4-micron wide exposed lines and begin making regular arrays this coming quarter. Author (TAB)

N67-35380# System Development Corp., Santa Monica, Calif.
AN INTERACTIVE SYSTEM FOR COMPUTING DEPENDENCIES, PHASE STRUCTURES AND KERNELS
John F. Burger, Robert E. Long, and Robert F. Simmons 29 Jun. 1967 32 p refs
(Contract AF 19(628)-5166)
(SP-2454/000/01; AD-654926)

Growing out of a need for the deep syntactic analysis of questions and possible answers in the Protosynthex approach to question answering, an automatic syntactic analysis system that is programmed in LISP is described. This is an interactive system that derives a grammar from hand-parsed sentences. It produces first a dependency analysis, which is then used as a basis for constructing an immediate-constituent surface phrase-structure tree. The resulting surface structure offers cues that allow the system to derive a kernel string for each presumed deep structure sentence that has been embedded in the surface structure. Interactive features include the capability for users to change the grammar, to select one of several presented parsings, to correct errors in the parsing, and to select various displays either on a CRT or in printed form. Author (TAB)

N67-35413# Naval Missile Center, Point Mugu, Calif.
ROOT LOCUS DETERMINATION FOR FEEDBACK CONTROL SYSTEM THROUGH USE OF DIGITAL COMPUTER TECHNIQUES
M. G. Olave 10 Jul. 1967 71 p refs
(NMC-TM-67-30; AD-654708)

The Naval Missile Center has developed a digital computer program that enables the engineer to obtain root locus plots easily and accurately for higher-order systems using the IBM 7094 computer and the SC 4020 plotter. The output is compatible with the one obtained by using the ESIAC analog computer, thus the complex plane on which values of s are plotted is the log s plane rather than the s plane. Author (TAB)

N67-35429# Aerospace Corp., El Segundo, Calif. Space Physics Lab.
COMPUTATION TECHNIQUES IN FOURIER TRANSFORM SPECTROSCOPY, DECEMBER 1965–JANUARY 1967
Charles M. Randall Mar. 1967 85 p refs
(Contract AF 04(695)-1001)
(TR-1001(9260-01)-8; SSD-TR-67-75; AD-654289)

The theory of Fourier transform spectroscopy is briefly reviewed, with emphasis on the computational methods required. The use of various functions for interpolation between data points is explored. None are found to have any advantage over the Dirac delta function, which leads to the simplest formula for computation. Algorithms have been found to speed the summation of the resulting series. Improvements of these algorithms are described which yield, with a minimum of additional computations, output points more closely spaced than permitted by sampling theory. The computer program written to include these features and instructions for use with a CDC 6000 series computer are presented. Author (TAB)

N67-35584# System Development Corp., Santa Monica, Calif.
EXPERIMENTAL INVESTIGATION OF USER PERFORMANCE IN TIME-SHARED COMPUTING SYSTEMS: RETROSPECT PROSPECT, AND THE PUBLIC INTEREST
H. Sackman 5 May 1967 105 p refs
(Contract F19628-67-C-0004)
(SP-2846; AD-654624)

This study was conducted to survey the field of user studies in time-sharing, and to develop a conceptual framework for cooperative, long-range applied research in this area--ultimately to serve the public interest in the development of the computer utility. The introduction traces the historical roots of user problems and develops the need for experimental studies of user performance in time-sharing systems. The literature review reveals a large and growing experimental lag between the extension of information services and verified knowledge of user performance. A conceptual framework for user studies in time-sharing is constructed following three basic steps. The first defines this field of inquiry. The definition essentially portrays this area as experimentally derived techniques and findings comprising the shared and verified experiences of the user community. The second step builds an evolutionary systems framework for user studies, encompassing the design, development and operation of user systems, and relating time-shared user systems to other types of computer-aided systems. The last is a classification of user problems into four broad areas--methodological, normative, behavioral, and social effectiveness. Numerous problems, hypotheses and recommendations for experimental investigation of user performance are made for each of these four categories. The study concludes with a plea for interdisciplinary applied research to meet the imminent challenge of the public information utility. TAB

N67-35592*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
METHOD OF ANALYZING DYNAMIC DATA CHARACTERIZED BY A TIME-VARYING FREQUENCY SPECTRUM
Arthur D. Brenza Washington, NASA, Sep. 1967 16 p
(NASA-TN-D-4161) CFSTI: $3.00 CSCL 09B

Many research areas are generating dynamic data whose frequency spectrum changes as a function of time, as is characterized by the data generated in the rocket-engine combustion instability program. From these data the instantaneous frequency spectrum at specific times during the test must be determined. Previous methods used in reducing these data were unsatisfactory; therefore, a different reduction method was required. A system was developed that produces a series of time history records from which the instantaneous frequency spectrum is determined. Author

N67-35659# Lincoln Lab., Mass. Inst. of Tech., Lexington.
[GENERAL RESEARCH AT LINCOLN LABORATORY] Quarterly Technical Summary Report, 1 Feb.–30 Apr. 1967
12 Jun. 1967 54 p refs
(Contract AF 19(628)-5167)
(ESD-TR-67-245; AD-654662) CFSTI: HC $3.00/MF $0.65

The summary covers the period from Feb 1 through April 30, 1967. It includes reports on data systems, radio physics, radar, engineering and solid state physics. TAB

N67-35743# Naval Oceanographic Office, Washington, D. C.
EXTENSION OF ATLAS TECHNIQUES BY ADP Informal Report
Richard M. Holcombe, Gordon H. MacDougall, and Eugene L. Bialek Jun. 1967 19 p
(IR-67-32; AD-654387)

During this era of the Computer Revolution and rapid information retrieval, the problems of meeting the users requirements in regard to marine environmental information are undergoing fundamental changes. The planning of Naval operations requires that detailed environmental characteristics be provided on short notice. The requirements imposed on this Office for this type of data are generally neither suitable nor practical in a small scale, hard copy atlas format. The purpose of this IR is to serve as an introduction to a series of IRs on each of the primary oceanographic disciplines defining problems and recommendations for adapting to automatic data processing methods at NAVOCEANO. Author (TAB)

N67-35783*# Stanford Univ., Calif. Instrumentation Research Lab.

LINC COMPUTER USER INTERACTIVE PROGRAMS AND MACRO INSTRUCTIONS

Walter E. Reynolds, Robert B. Tucker, Timothy B. Coburn, and James C. Bridges 1 Jun. 1967 96 p refs

(Grant NsG-81-60; Contract AF 49(638)-1599; Grant NIH FR-00151)

(NASA-CR-88103; IRL-1055; AFOSR-67-1465; AD-654736) CSCL 09B

This report describes four program packages for use on the LINC computer: (1) A program package which enables the LINC and a Teletype to be used as a very sophisticated desk calculator including graphical output with a Calcomp plotter; (2) A general purpose double precision floating point subroutine package for the LINC; (3) A set of input-output routines providing for the communication of octal, decimal and alphanumeric information via a Teletype; and, (4) Additional information on the LOSS system. TAB

N67-35848*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

A PRODUCTION CONTROL AND ACCOUNTING SYSTEM

Donald E. Jamison Dec. 1966 105 p refs

(NASA-TM-X-55891; I-564-66-595) CSCL 09B

A study of the methods of production control and accounting information storage used by the Data Processing Branch at Goddard Space Flight Center is presented. An alternate method of automating many of the functions of the present data handling system is discussed. Many of the repetitive tasks associated with punched cards have been eliminated and the accounting data has been consolidated for instant access. The study has shown how an available, government owned computer, the IBM 1401 can be utilized effectively to meet the current system requirements and still have the capability for expansion. This results in two fold savings for NASA, in that it takes advantage of existing equipment, and higher priced computer systems that should be used for direct support of GSFC's scientific missions. Author

N67-35855# California Univ., Livermore. Lawrence Radiation Lab.

SURVEY OF GRAPHIC DATA PROCESSING EQUIPMENT FOR COMPUTERS

Robert K. Cralle and George A. Michael Apr. 1967 77 p refs Revised

(Contract W-7405-ENG-48)

(UCRL-70195, Rev. 1) CFSTI: HC $3.00/MF $0.65

This report says in a variety of ways that computer-based graphic data processing is the wave of the future and that the chief problem encountered is trying to make it available to many people is ultimately its high cost. Whether these come down very much or not, there also will always be a corresponding level of technical difficulties that have to be surmounted. Some of the problems recognized so far are discussed and a brief survey of some of the equipment currently available is presented. Author (NSA)

N67-35864*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

A COMPUTER CONTROL SYSTEM FOR AN ADVANCED OAO

John A. Hrastar Aug. 1967 36 p refs

(NASA-TM-X-55895; X-732-67-363) CSCL 09B

The purpose was to determine the feasibility of using an onboard digital computer and strap-down inertial reference unit for attitude control of an advanced OAO spacecraft. An integrated, three-axis control law was assumed which had been previously proven stable. Its principal advantage is the ability to complete three-axis reorientations over large angles. This system, although apparently complex, has the effect of simplifying the overall system. This is because a reorientation is a simple extension of a hold or point operation, i.e., mode switching may be simplified. The study indicates that a system of this type is feasible and offers many advantages over present systems. The time for a reorientation using this type of control is considerably shorter than the time required using more conventional methods. The computer and inertial reference unit used in the study had the characteristics of systems presently under development. Feasibility, therefore, is within the present state of the art. Author

N67-35869# Picatinny Arsenal, Dover, N. J. Engineering Sciences Lab.

COMPUTER PROGRAM FOR LINVILL MODEL OF DISTRIBUTED DEVICES

James H. Fahs Jun. 1967 37 p refs

(PA-TR-3526; AD-654982)

The mathematical modeling of solid state devices has become quite important in connection with the effort to predict the operation of such devices under critical conditions. The Linvill model is one of several types of models which have been proposed. This report describes a computer program written in FORTRAN IV to solve the Linvill model of a P-N diode as developed by Mr. M. Allen. It consists of a main program with four sub-programs. Each program is described and directions are given for the use of the total program. The input and output of a sample problem are shown. Flow charts and listings are supplied for all programs. Author (TAB)

N67-35874* Massachusetts Inst. of Tech., Cambridge. Engineering Projects Lab.

MANTRAN: A SYMBOLIC LANGUAGE FOR SUPERVISORY CONTROL OF AN INTELLIGENT REMOTE MANIPULATOR

David James Barber (M.S. Thesis) Jan. 1967 77 p refs

(Grant NsG-107/22-009-002)

(NASA-CR-88271; DSR-70283-3) CSCL 09B

Transmission delay inherent in deep space communication requires that a remote manipulator be able to act on its environment without continuous human control. This demands a flexible command structure which accepts symbolic and conditional instructions from a human operator. This thesis considers the development of a special computer language to provide such a structure. It effects human-directed subgoals yet allows the manipulator's interactions with the remote environment to determine fine scale control of the manipulation task. The structure and syntax of this language are described. Techniques are suggested to create a flexible and versatile manipulation system capable of performing in a deep space environment. Author

N67-35898# RAND Corp., Santa Monica, Calif.

SOME IMPLICATIONS OF AUTOMATED DESIGN ON THE ENGINEERING PROCESS

Lawrence S. Hill Jul. 1967 16 p refs Presented at the Symp. on Use of Computers in Eng. of the Ann. Meeting of the Am. Assoc. of Cost Engr., Cleveland, 10 Jul. 1967

(P-3625; AD-655065)

Advancements are now available for the partial mechanization of production drawings and even more in the area of schematics.

Computers have been available for design calculations for more than fifteen years. Advancements are reflected in tape-controlled coordinate plotters. These and other improvements plus the possible automation of all phases of engineering design are considered in this Paper. TAB

N67-36019# Naval Research Lab., Washington, D. C.
THE THROUGHPUT AND COST EFFECTIVENESS OF MONOPROGRAMMED, MULTIPROGRAMMED, AND MULTIPROCESSING DIGITAL COMPUTERS
Bruce Wald (Ph.D. Thesis) 17 Apr. 1967 136 p refs
(NRL-6549; AD-654384)

A generalized model of a digital computer system with a workload drawn from a proffered infinite workload was investigated to determine the factors that affect throughput and cost effectiveness to allow optimization of the system parameters. Throughput was defined as the sum of the products of the cost of each component and the proportion of the time each component was beneficially used. Cost effectiveness was defined as the quotient of throughput and system cost, with unity being the ideal quotient. TAB

N67-36059# California Univ., Berkeley. Lawrence Radiation Lab.
ON-LINE REAL-TIME OPERATION OF A PDP-7 DATA-TAKING SYSTEM
Lloyd B. Robinson and J. D. Meng 16 Mar. 1967 11 p refs Presented at the Digital Equipment User's Soc. Meeting, Berkeley, Calif., 4–5 Nov. 1966
(Contract W-7405-ENG-48)
(UCRL-17220; CONF-661114-2) CFSTI: HC $3.00/MF $0.65

Hardware and software developments which permit simultaneous use of a PDP-7 computer for both data-taking and preliminary data analysis are described. The hardware includes a set of remote-control consoles, and a memory-protection system. System programming is not yet complete, but currently operating programs allow concurrent data-taking from as many as four remote stations, with versatile CRT display, graph plotting, storage on both IBM-compatible and micromagnetic tape, and printout on an electric typewriter. A third-order polynomial background-fitting routine was also written, mainly as a demonstration of the capabilities of the system, since most data analysis should be carried out with the CDC-6600 facility at the main computer center. Work was also done to simplify the preparation of future machine-language programs for the PDP-7. Author (NSA)

N67-36083*# International Information, Inc., Philadelphia, Pa.
STUDY TRIP IN THE USSR
M. Bancarel Washington, NASA, Dec. 1966 12 p Transl. into ENGLISH of the book "Voyage d'Etudes en URSS"
(Contract NASw-1499)
(NASA-TT-F-10600) CFSTI: HC $3.00/MF $0.65 CSCL 09B

A broad evaluation of Soviet computer technology is given. Applications in government and industry are summarized. General observations are presented on the status of operator and programmer personnel training programs. Several computer systems are sketched briefly, including the Ural, Besma, and Omega series. E.C.

N67-36160# COMRESS, Inc., Washington, D. C.
PROPOSED SYSTEM CONCEPT FOR REAL-TIME PROCESSING OF AUTODIN MESSAGES
Bedford, Mass., AFSC, Electron. Systems Div., May 1967 48 p
(Contract F19628-67-C-0259)
(ESD-TR-67-294; AD-654749)

The report is the proposed system concept for the real-time processing of AUTODIN messages at the Data Services Center, HQ USAF. The description of the present system emphasizes the batch processing nature of the present computer programs, and their interrelationships with each other and with the manual RCS control system. The problems that characterize the present system are principally those of the time that elapses between receipt of a message on the AUTODIN terminal and the identification of errors that invalidate the message and require further contact with the originator. The manual RCS control file was identified as being one of the major elements of this time lapse because of the periodic manual transcription of incoming messages to handwritten control cards. The proposed system emphasizes the desirability of performing data edits immediately upon receipt of each message and the instantaneous transmission of an error message to the originator when the incoming message has failed a format edit. The real-time concept is also the main element of management control through the Command and Query Terminal that provides on-line management decision-making ability without sacrificing any of the advantages of the computer-controlled real-time system. Author (TAB)

N67-36227# System Development Corp., Santa Monica, Calif.
ON-LINE TRANSLATION OF NATURAL LANGUAGE QUESTIONS INTO ARTIFICIAL LANGUAGE QUERIES
Charles H. Kellogg 28 Apr. 1967 51 p refs
(SP-2827-000-00; AD-654595)

The report describes a computer program that demonstrates one approach to the problem of relating questions, posed in a limited subset of English, to a set of facts stored in an on-line data base. The program, called CONVERSE, is designed to use an existing data management system, to provide answers to questions. Where possible, CONVERSE translates an English question into one or more file-searching procedures. If complete translation is not possible, the program provides a user with information that may help him in defining new terms or rephrasing his question into acceptable English terms. CONVERSE accepts generic or browsing types of questions that ask for information about the data base as well as questions of a more specific nature. The translation procedure is based on a generative model of syntax and semantics that is comprehensive enough to automatically resolve some forms of syntactic and semantic ambiguity. A definition of fact is introduced to help specify semantic associations between questions and data values. A dictionary and a series of syntactic, semantic interpretation, and query construction rules constitute a file of interpretive data that is used by the program in effecting question-to-query translation. Author (TAB)

N67-36241# Max-Planck-Institut fur Physik und Astrophysik, Munich (West Germany).
PROGRAMMING FOR FLYING SPOT DEVICES
B. W. Powell, ed. and P. Seyboth, ed. Apr. 1967 688 p refs Proc. of the Conf. held in Munich, 18–20 Jan. 1967; Sponsored by Bundesmin fuer Wiss. Forschung, IBM Deut. and Max-Planck-Ges. zur Foerder. der Wiss.

Papers on automatic data evaluation of photographs from spark and bubble chambers are presented. For individual titles see N67-36242–N67-36279.

N67-36242# National Inst. for Research in Nuclear Science, Harwell (England). Rutherford High Energy Lab.
CYCLOPS: A FLYING SPOT DIGITISER FOR SPARK CHAMBER FILM ANALYSES
J. F. MacEwan, and P. H. Sharp *In* Max-Planck-Inst. fuer Phys. und Astrophys. Programming for Flying Spot Devices Apr. 1967 12 p refs (See N67-36241 21-08)

Principles of operation, performance characteristics, and associated equipment for a flying spot digitiser (CYCLOPS) designed for use in spark chamber film analyses are described. The flying spot (0.001" diameter) is generated by a Ferranti precision cathode ray tube with magnetic deflection. The spot is deflected over 7 cm of the tube face in 2 milliseconds, and a demagnified image (X2) of the scan line is projected simultaneously on the film and reference grating. Reference pulses are generated every

0.002" and interpolation between them (X16) allows measurement of position on the film to 0.001" in the vertical direction. The TV type raster is generated by moving the film slowly past the scan line (typically 1"/sec) and a Heidenhain linear encoder is used to measure position in the horizontal direction to 0.001". The film is advanced using a vacuum capstan and stepping motor. The command signals and control of the device are directed by the DDP 2pv comouter and the data are fed directly into the memory and finally stored on magnetic tape. A 45° calibration grid was used to check the accuracy of the device. Results showed that the grid could be measured to an accuracy of 1 least count for X and Y positions, i.e., 2.5μm and 3μm respectively, and that the measurement was repeatable. Tests also indicate that with manual counting the CRT sees 90% of all sparks on the film under the best conditions. Limited diagnostic data checks from the scanner have proven to be effective in diagnosing faults. S.C.W.

N67-36243# National Inst. for Research in Nuclear Science, Harwell (England). Rutherford High Energy Lab.
SOFTWARE FOR THE FSD CYCLOPS IN OPERATION AT THE RUTHERFORD HIGH ENERGY LABORATORY
A. J. Redman, J. Sparrow, and D. J. Wagon *In* Max-Planck-Inst. fuer Phys. und Astrophys. Programming for Flying Spot Devices Apr. 1967 16 p ref (See N67-36241 21-08)

Software for the DDP 224 computer which controls the operation of the Cyclops flying spot digitizer used in measuring spark chamber film is described. Reported are results of experiments in which Cyclops was used in studies of the decay of $K_L^0 - 2\pi^0$. Analyzed were events consisting of 4 γ-rays giving rise to electron showers in the chambers (two per chamber). Procedures used in spark reconstruction and shower finding are discussed. Thirty five hundred events were measured using Cyclops. Measurements were made on ≈150 rolls of film producing ≈150 magnetic tapes. The controlling program was found to be reliable and handling most fault conditions. Picture numbers were found with 95% reliability. Displays of sparks found compared with the original events showed that with reversed developed film some 90% of the sparks were digitized successfully. In the case of normal film the success of the operation depended critically on the discriminator setting but was 85% for the optimum setting on any one chamber. The total number of events lost completely up to this stage was 2%. The overall shower finding success rate was 60%. Any one shower could be found with a probability of 97% but each event required the recognition of four showers bringing the overall efficiency to 75% on those events attempted. Results of comparative data from a sample of events successfully processed by Cyclops and spark counts performed manually for the same events are illustrated. S.C.W.

N67-36244# Deutsches Elektronen-Synchrotron, Hamburg (West Germany).
AUTOMATIC PROCESSING OF SPARK CHAMBER PICTURES AT DESY
U. Becker, K. Dahlmann, K. Hoenne, J. Weber, and J. H. Smith (Ill. Univ., Urbana) *In* Max-Planck-Inst. fuer Phys. und Astrophys. Programming for Flying Spot Devices Apr. 1967 18 p refs (See N67-36241 21-08)

Described is the development of equipment and data processing techniques used in the automatic processing of spark chamber pictures for the following experiment $\gamma + p \rightarrow p + \rho^0$. Developed was a flying spot digitizer whose specifications were selected on the basis of the characteristics of these pictures. Techniques used in fixing data; pattern recognition and reconstruction are described. In the experiment described 13000 pictures were taken. Of these, 7800 were usable for physics. These pictures were measured with the following result: (1) 7800 pictures (100%) processed; (2) 5900 pictures (76%) measurement successful; (3) 1900 pictures (24%) measurement failed. Failures were attributed to the following causes: (1) construction of two tracks in the side view impossible (12%); (2) ambiguous correlation between side view and top view tracks (6%); (3) improper film development (5%); and (4) identification of two tracks in the top view impossible (1%). The initiation of a new spark chamber experiment which was designed for automatic data processing, and which will involve several hundred thousand pictures is also reported. It is surmised that with the experience gained from the reported experiment the quality of the pictures for the proposed experiment can be improved, thus increasing the total efficiency to more than 90%. S.C.W.

N67-36245# Pennsylvania Univ., Philadelphia.
A FULLY AUTOMATIC HPD SYSTEM FOR SPARK CHAMBER PICTURES
Olin B. Van Dyck *In* Max-Planck-Inst. fuer Phys. und Astrophys. Programming for Flying Spot Devices Apr. 1967 25 p refs (See N67-36241 21-08)

Described is the development of a fully automatic Hough–Powell system that was used in the on-line processing of data from a spark chamber experiment. The experiment was designed to study lambda production polarization and differential cross section in the reaction $\pi^- + P \rightarrow \Lambda^0 + K^0$. The reaction was studied in the energy range of rapidly changing polarization, which corresponds to a range of incident pion kinetic energies from lambda threshold at 775 MeV to 1075 MeV. A liquid hydrogen target was used. The lambdas were detected by decay into $\pi^- + P$. Discussed are operations of the digitizer; the analysis program which reads the digitized coordinates into memory and searches through each region of the picture for whole lines; the track searching routine; and program performance and accuracy. S.C.W.

N67-36246# Stanford Univ., Calif.
HUMMINGBIRD, AUTOMATIC FILM DIGITIZERS AT THE STANFORD LINEAR ACCLERATOR CENTER
J. van der Lans *In* Max-Planck-Inst. fuer Phys. und Astrophys. Programming for Flying Spot Devices Apr. 1967 22 p refs Sponsored by AEC (See N67-36245 21-08)

Two Hummingbird spark chamber film digitizers which are being used at the Stanford Linear Accelerator Center are described. These devices are controlled by an IBM 360/50 computer. Operations used in control and data transfer, scanning and digitization, and film transport are discussed. Significant differences between different models designated Hummingbird I and Hummingbird II are tabulated, and performance data for the two devices are presented. Stability analyses of these devices indicate that they appear promising for the scanning and measuring of bubble chamber film. S.C.W.

N67-36247# Stanford Univ., Calif.
SYSTEMS FOR THE HUMMINGBIRD AT SLAC
C. Dickens *In* Max-Planck-Inst. fuer Phys. und Astrophys. Programming for Flying Spot Devices Apr. 1967 14 p refs Sponsored by AEC (See N67-36241 21-08)

Discussed is the development and incorporation of the Hummingbird I scanner into the IBM 360/50 system. A general description to the final system is as follows: the scanning system consists of the Hummingbird I, an IBM 360/50 with tapes and disks, an IBM printer and card reader, a 2250 Model I display scope with keyboard and lightpen, an IBM 2701 control unit with a parallel data adapter, an OS-360 software system provided by IBM, and an open-ended set of Fortran subroutines to tie the scanning system together. The set of Fortran routines which give the scanning system its dynamic structure is completely open ended and starting from a basic scanner control nucleus may be developed for a specific application into a complete analysis system. The basic program nucleus may be used as a stand alone program or merely as a subroutine for acquiring data and controlling the scanner. Also described are basic program organization, basic program control, basic output, I/O interface, the CBX system, the N–P system, an on-line SUMX control and display feature, and

peripheral efforts involving the development of a set of routines to reduce a small set of bubble chamber photographs on the Hummingbird I as a test of the hardware. Additional projects cited include a program designed for completely automatic processing with on-line debugging, and a second which includes a human scanner using a display scope for normal processing. S.C.W.

N67-36248# European Organization for Nuclear Research, Geneva (Switzerland).
THE MEASUREMENT OF SPARK CHAMBER FILM AT CERN USING THE HPD I
R. A. Bowen, H. E. Davies, J. C. Lassalle, J. Wilson, and P. Zanella *In* Max-Planck-Inst. fuer Phys. und Astrophys. Programming for Flying Spot Devices Apr. 1967 16 p refs (See N67-36241 21-08)

Described are experiments in which the HPD-1 was used to measure spark chamber film; experience obtained with operating the HPD on-line to the CDC 6600 computer; and studies focusing on the standardization of programs to reduce the programming time for a new experiment. Experiments reported include studies of the three $-\pi$ decay of the particle; X^0 particle decay; and high resolution mass spectrometric studies of two body decays of resonances. Changes made to the IBM 7090 program while converting it to run on the CDC 6600 are discussed. Using experience gained from processing several experiments with two computers and two FSDs (HPD and LUCIOLE), an attempt is being made to rationalize and standardize the programs for the automatic processing of spark chamber film at CERN. The aim of the standardization is to produce a general program which can easily be adapted to new experiments, to run on a different computer or to use either HPD or LUCIOLE. Two principles on which the program structure is based are described. Also described are advantages and limitations of standardization. It is hoped that when the system is completed, the effort needed to produce an analysis program for a new experiment, except for new pattern recognition routines which may have to be written and tested, will be of the order of three man months. S.C.W.

N67-36249# European Organization for Nuclear Research, Geneva (Switzerland).
THE MEASUREMENT OF SPARK CHAMBER FILM AT CERN USING LUCIOLE
T. F. Andersson, P. M. Blackall, J. Daub, A. E. Head, M. B. Metcalf et al *In* Max-Planck-Inst. fuer Phys. und Astrophys. Programming for Flying Spot Devices Apr. 1967 26 p refs (See N67-36241 21-08)

This paper describes in general terms the operating and programming methods used to automatically scan and measure spark chamber pictures using the cathode ray tube digitizer LUCIOLE. Author

N67-36250# European Organization for Nuclear Research, Geneva (Switzerland).
A SIMPLE COMPUTER-CONTROLLED FLYING SPOT DIGITIZER FOR SPARK CHAMBER PHOTOGRAPHS
P. Scharff-Hansen and T. R. Willitts *In* Max-Planck-Inst. fuer Phys. und Astrophys. Programming for Flying Spot Devices Apr. 1967 15 p refs (See N67-36241 21-08)

Described is a simple flying spot digitizer for scanning and measuring spark chamber film which uses a small computer to control a commercial oscilloscope. Discussed are the optical system and film transport methods; techniques and equipment used in controlling spot position; film layout methods; the program used which was written in assembly language for both the IBM 650 and the SDS 920 computers; techniques used in checking accuracy and making corrections; and off-line CDC 3800 reconstruction operations. Experiments in which this device was used are cited. S.C.W.

N67-36251# Paris Univ. (France). Institut de Physique Nucleaire.
UTILIZATION OF AN ON-LINE MEASURING SYSTEM
C. Ouannes, B. Garic (Coll. de France), B. Makowski, and M. Sauvage *In* Max-Planck-Inst. fuer Phys. und Astrophys. Programming for Flying Spot Devices Apr. 1967 8 p (See N67-36241 21-08)

Described is an on-line bubble chamber measuring system which is composed of six IEP and five SMP measuring machines connected to a CDC 3600 computer. Specific features of the measuring system are: (1) it utilizes a computing center which also handles other duties; and (2) geometrical reconstruction is performed in real time immediately after each measurement. The system was utilized in an effort to perfect the SMPs, and to run production on the IEPs. Tests on the SMP machines gave a hardware efficiency of 55%; however, this low efficiency was attributed to incorrect mechanical and electronic adjustments. A hardware efficiency of 95% was obtained on the IEPs. Data on the success rates in on-line THRESH for a sample of 100 events are tabulated. Also summarized are average measuring rates. Plans to produce about 50 events/h with correct geometrical reconstruction using a system of eleven measuring devices are discussed. S.C.W.

N67-36252# Purdue Univ., Lafayette, Ind.
THE PURDUE SMP SYSTEM
Richard S. Christian, Frank J. Oeffler, Arthur Z. Kovacs, Robert L. McIlwain, Jr., George W. Tautfest et al *In* Max-Planck-Inst. fuer Phys. und Astrophys. Programming for Flying Spot Devices Apr. 1967 12 p (See N67-36241 21-08)

Discussed are present and future time sharing aspects of the Purdue SMP measuring system. Described are the present computer configuration used at Purdue University, memory allocation in the present computer system, a proposed computer configuration, memory allocation in the proposed IBM 360/40 computer, and proposed input-output organization. These studies were undertaken in an effort to overcome the cost of using separate computers for SMP control and general operations; and to increase the ability to do multi-programming in the computer. S.C.W.

N67-36253# Glasgow Univ. (Scotland).
EXPERIENCE WITH THE GLASGOW SMP SYSTEM
G. K. S. Browning, G. H. Robertson, and C. J. Robinson *In* Max-Planck-Inst. fuer Phys. und Astrophys. Programming for Flying Spot Devices Apr. 1967 13 p (See N67-36241 21-08)

Reviewed are experiences with three Glasgow SMP measuring machines and associated equipment which were used in spark chamber film analyses. The machines are controlled by an IBM 7044 computer, and the programming system is based on the executive program written by John Munson which time shares the computer between the measuring machines. Differences between the European SMP's and the Berkeley SMP's are discussed. Also described are Glasgow generated innovations to the executive routine, vertex subroutine, fiducial subroutine, measuring mode, and kernel routine. Comparative data on the performance of SMP machines and conventional machines are included. S.C.W.

N67-36254# Heidelberg Univ. (West Germany). Institut für Hochenergiephysik.
SMP—HEIDELBERG Status Report
P. Mokry *In* Max-Planck-Inst. fuer Phys. und Astrophys. Programming for Flying Spot Devices Apr. 1967 12 p refs (See N67-36241 21-08)

Experiences with a system of four SMP machines used to measure photographs from a hydrogen bubble chamber experiment with 1 GeV/c K^- are reported. The machines are used on-line with an IBM 7040 computer. The measuring program consists of the executive program originally written by John Munson for the University of Hawaii SMP system, a guiding KERNAL

written in Glasgow in collaboration with Heidelberg, several filtering subroutines of the Berkeley SMP system, and special routines for point mode filtering and vertex point determinations. Described are modifications to the CROSS subroutine and the point measurement mode. Results of an evaluation of the overall measuring errors from the distribution of distances between pairs of fiducials measured on different frames of the same film, are described. Also described are two methods for testing the consistency of track measurement. S.C.W.

N67-36255# Paris Univ. (France). Institut de Physique Nucleaire.
PROPOSAL FOR A REAL-TIME PROCESSING OF "POST KINEMATICS" DATA
C. Ouannes, B. Garic (Coll. de France), and B. Makowski *In* Max-Planck-Inst. fuer Phys. und Astrophys. Programming for Flying Spot Devices Apr. 1967 9 p (See N67-36241 21-08)

Described is a real time processing system, designated SUMX. TR, for analyzing bubble chamber post-kinematics data. The proposed system gives the user access to a data library and allows him to obtain histograms immediately. The system is designed to give the physicist a tool for extracting physical results from the DST (magnetic tape storage) efficiently, economically, and with very short delays. Data processing equipment used in conjunction with the proposed system include a CDC 3200 which monitors eleven measuring devices and executes simultaneously 3 peripheral operations (tape to printer, card to tape, etc.) for the 3600; and a CDC 3600 which executes classical computations and THRESH in a real time mode. The system is designed to include two interrogation stations as peripheral equipment: one remote station and a local station. In addition, the SUMX. TR system requires a typewriter, a card reader, and a printer at each interrogation station. The CDC 3300 executive system (MASTER) allows the computer to be shared by several programs being executed simultaneously. Data on the distribution of the work load on the 3300 are included. The SUMX. TR work is classifiable into the following categories in descending order of priority: analysis jobs, urgent SUMX, and production SUMX. It is surmised that the system takes advantage of the evolution of the present techniques, and is a beginning of what in the future will be an automatic handling of bubble chamber data. S.C.W.

N67-36256# European Organization for Nuclear Research, Geneva (Switzerland).
INTRODUCTION TO A DISCUSSION ON "THE USE OF COMPUTERS IN FSD SYSTEMS"
D. H. Lord *In* Max-Planck-Inst. fuer Phys. und Astrophys. Programming for Flying Spot Devices Apr. 1967 14 p (See N67-36241 21-08)

Introductory remarks to a discussion on the future use of computers in flying spot devices (FSD) bubble or spark chamber data processing systems are presented. Discussed are design concepts and the development of earlier FSD systems during the period 1960/1961, and four main areas in the FSD system where computers are and will be used. These four areas are: hardware; data processing (FSD operation, gate and filter); data processing (geometry, kinematics, and statistics); and overall management. The primary questions posed in these introductory statements are: (1) What is the best choice for the tasks of the real time and non-real time parts of the FSD programs? (2) How can this choice be best implemented, i.e., single or double computer system? (3) Can FSD's be successfully operated within a general, time sharing computer service? (4) Will the use of minimum or zero guidance programs demand a different configuration? (5) For an overall management system, what will represent a satisfactory balance between the high equipment costs and the benefits they will bring toward the smoothness and rapidity with which experiments can be fully processed? The accompanying discussion cites efforts of several laboratories and research organizations engaged in FSD programs. S.C.W.

N67-36257# Brookhaven National Lab., Upton, N. Y.
PROBLEMS AND PROGRESS IN THE INTEGRATION OF AN FSD MEASUREMENT FACILITY AND A BUBBLE CHAMBER PHYSICS RESEARCH PROGRAM
D. J. Crennell, B. B. Culwick, P. V. C. Hough, J. A. Nardi, I. O. Skillicorn et al *In* Max-Planck-Inst. fuer Phys. und Astrophys. Programming for Flying Spot Devices Apr. 1967 19 p refs (See N67-36241 21-08)

Design and performance data for the Brookhaven FSD system are reviewed, and efforts focusing on the integration of the FSD measurement facility with the bubble chamber physics research program are discussed. S.C.W.

N67-36258# Brookhaven National Lab., Upton, N. Y.
SOME SPECIAL FEATURES OF THE BROOKHAVEN REAL-TIME FSD PROGRAM
K. Abrams, A. Goldberg, P. V. C. Hough, S. Jessup, J. A. Nardi et al *In* Max-Planck-Inst. fuer Phys. und Astrophys. Programming for Flying Spot Devices Apr. 1967 18 p (See N67-36241 21-08)

Reported are improvements to that part of the Brookhaven flying spot device (FSD) program system which (1) controls the FSD, (2) finds fiducials, and (3) gates the contents of 400 micron wide roads onto magnetic tape for subsequent filtering on the CDC 6600. The new program, designated GNASH, is constructed of three chains. Chain one sets up the program constants appropriate to the FSD (35 mm or 70 mm), to the chamber (20", 30", or 80"), and to the experiment. Chain two is the production chain which is in core continuously for the measurement of one roll of film in one view. Chain three is a summary chain which provides a number of tallies and histograms of measured quantities for control of the quality of measurement. The main program in each chain is an executive program that is restricted to making decisions about the ordering of the work and to calling subroutines which perform the work. Documentation is largely integral, i.e., a paragraph or two of general description is included in comment cards at the beginning of each subroutine, and each program statement is accompanied by a sentence or two of comments. Data on buffer space capability; road control; the GATE routine; data check procedures; beam bubble density analysis; run summary routines, and progressive cybernation features, are included. It is concluded, on the basis of six months experience with GNASH, that the most important feature of the program is its civilized nature, i.e., it is mostly Fortran, well subroutined, well documented, and easily and reliably changed. S.C.W.

N67-36259# European Organization for Nuclear Research, Geneva (Switzerland).
EXPERIENCE WITH THE CERN HPD ROAD GUIDANCE SYSTEM
W. Blair, M. Foster, Ph. Gavillet, D. Holthuizen, M. Howie et al *In* Max-Planck-Inst. fuer Phys. und Astrophys. Programming for Flying Spot Devices Apr. 1967 22 p refs (See N67-36241 21-08)

The current version of the road guidance system which is used with the CERN HPD 1 on-line to a CDC 6600 computer, and which was designed for large scale production, is briefly outlined. Included is a discussion of its performance, in terms of the quantity of measurements achieved. Results indicate that measurements obtained with the system are satisfactory with respect to quality and are in no way inferior to IEP results. The quality of measurements produced corresponds to an effective speed of little more than half the maximum speed of the HPD 1. Although a continuous operation at maximum speed is impossible in any system, it is concluded that too large a fraction of the time loss is caused by the present computer operating system and hardware. S.C.W.

N67-36260# College de France, Paris.
PROGRAMMING SYSTEM OF THE COLLEGE DE FRANCE OFF-LINE HPD
B. Equer, B. Ton That, and A. Volte *In* Max-Planck-Inst. fuer Phys. und Astrophys. Programming for Flying Spot Devices Apr. 1967 12 p refs (See N67-36241 21-08)

Improvements to the programming system of the Paris off-line HPD are described, and results obtained on 5000 four prong events are presented. S.C.W.

N67-36261# College de France, Paris.
A NEW HPD FILTERING TECHNIQUE FOR BUBBLE CHAMBER PICTURES
J. Adler, M. Bloch, B. Equer, and A. Volte *In* Max-Planck-Inst. fuer Phys. und Astrophys. Programming for Flying Spot Devices Apr. 1967 36 p refs (See N67-36241 21-08)

Described is a new HPD filtering technique for analyzing bubble chamber film. The method was developed in an effort to: (1) simplify the running and maintenance of the program for production; (2) reduce the machine time necessary for the analysis of each event; and (3) verify certain principles for pattern recognition as applied to HPD measurements, i.e., the information quantity. Included are data on general principles used in developing the prescribed techniques which focus on the maximization of the mutual information quantity on track parameters contained in the set of HPD digitizations; (2) methods and programs (PREFILTER and FITLIN) which are applications of these general principles; and (3) a generalized prefilter approach which performs a special class of linear transform on the digitizations. S.C.W.

N67-36262# College de France, Paris.
COMPUTER CONTROLLED ELECTRONIC GATE FOR THE REDUCTION OF HPD DIGITIZINGS
Claude Guignard *In* Max-Planck-Inst. fuer Phys. und Astrophys. Programming for Flying Spot Devices Apr. 1967 9 p refs (See N67-36241 21-08)

Described is a computer controlled electronic gating technique which reduces the number of digitizings in an off-line HPD where the output is a magnetic tape. Advantages of the proposed method are that it increases the number of events recorded on a magnetic tape; reduces the reading time of the tape during subsequent processing; reduces the memory allocation for data during processing; and reduces the limitation on the speed of the scan which comes from time used for processing between input to the computer and output to the magnetic tape. The principle of pregating, pregating times with a CDC 160A computer, and the need for computer controlled electronic gates are discussed. S.C.W.

N67-36263# College de France, Paris.
HPD PERFORMANCE UNDER CONTROL OF A SMALL COMPUTER
Ph. Leblond *In* Max-Planck-Inst. fuer Phys. und Astrophys. Programming for Flying Spot Devices Apr. 1967 7 p refs (See N67-36241 21-08)

Results of experiments designed to determine the feasibility of controlling the Paris Hough–Powell Device (HPD) with a small computer (CDC 160A) are reported. Described are problems encountered during measurements of hydrogen bubble chamber photographs in a 3 GeV/c K^- beam, and modifications to the system which focused on eliminating problems of memory space and processing time are discussed. S.C.W.

N67-36264# Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires.
STATUS OF HPD PROGRAMS AT SACLAY
J. P. De Brion, C. Frank, M. Grandidier, A. Leveque, G. Riols et al *In* Max-Planck-Inst. fuer Phys. und Astrophys. Programming for Flying Spot Devices Apr. 1967 5 p refs (See N67-36241 21-08)

Preliminary data from advanced tests of the Saclay HPD (Hough–Powell Device) performance with the CDC 160A computer are reported. The whole system, hardware included, was tested with 700 K p 2-prong events photographed in the 81 cm bubble chamber. All events were scanned and premeasured including those with very short tracks. The entire sample was measured using only the normal scan, and was remeasured after both scans were operational. Only data from the first measurement has been analyzed. In addition, all events were measured on IEPs. Results between the two measurements were compared and a bias was found which was attributed to the fact that different fiducials were measured. On a sample of 3195 track-views accepted in MIST (an IBM 7094 program for processing rough measurement data) for the normal scan, 190 (6%) were rejected at the FILTER (an IBM 7094 program in FORTRAN II) stage; 110 of these were short tracks. Of all the tracks which entered FILTER and for which reconstruction was attempted, 21% were rejected, including both FILTER rejects and abnormal scan tracks. These comparative studies are still in progress, and it is surmised that production will be intiated in the near future, if results prove satisfactory. S.C.W.

N67-36265# Bologna Univ. (Italy). Istituto Nazionale di Fisica Nucleare.
PRELIMINARY RESULTS OF THRESH AND GRIND OBTAINED FROM FSD–IBM 7094 MEASURED EVENTS
M. A. Di Lazzaro, M. L. Luvisetto, M. Masetti, and G. Misuri *In* Max-Planck-Inst. fuer Phys. und Astrophys. Programming for Flying Spot Devices Apr. 1967 13 p (See N67-36241 21-08)

Preliminary results of a kinematical analysis of the first events measured with the FSD–IBM 7094 are presented. The experiment concerned the 4 and 6 prong interactions of 5 GeV/c in deuterium occurring in the 80 cm bubble chamber at CERN. Premeasurements were input to the program MIST which produces the scan tape for the program HAZE. This program controls the FSD and produces the input for the programs THRESH and GRIND, which perform the geometrical and kinematical analysis of the events. Techniques used in determining the rejection rate of the measured events; the accuracy of the first events measured; FSD measurement reproducibility; and FSD measurement precision are described. Results obtained with the FSD indicate that systematic errors are neglible. S.C.W.

N67-36266# Bologna Univ. (Italy). Istituto Nazionale di Fisica Nucleare.
THE SYSTEM FSD–IBM 7094 BUILT AT CNAF
E. Carita, M. L. Luvisetto, M. Masetti, G. P. Sini, D. Venturi et al *In* Max-Planck-Inst. fuer Phys. und Astrophys. Programming for Flying Spot Devices Apr. 1967 9 p refs (See N67-36241 21-08)

This report describes briefly both the hardware and the software of the FSD–IBM 7094 system which is now in operation at CNAF. Future developments are also summarized. The main differences with the other systems previously made are outlined. Author

N67-36267# Bologna Univ. (Italy). Istituto Nazionale di Fisica Nucleare.
CALIBRATION AND TEST PROGRAMS FOR THE FSD SYSTEM
M. L. Luvisetto, M. Masetti, and A. Mignoli *In* Max-Planck-Inst. fuer Phys. und Astrophys. Programming for Flying Spot Devices Apr. 1967 25 p ref (See N67-36241 21-08)

Described is a chain of programs which computes all required constants related both to the HPD (Hough–Powell Device) and the film to be analyzed. In addition, a check program which detects possible malfunctions of the HPD is described. S.C.W.

N67-36268# Bologna Univ. (Italy). Istituto Nazionale di Fisica Nucleare.
FUTURE DEVELOPMENTS OF CNAF FSD SYSTEM

M. L. Luvisetto and M. Masetti *In* Max-Planck-Inst. fuer Phys. und Astrophys. Programming for Flying Spot Devices Apr. 1967 11 p *ref* (See N67-36241 21-08)

On-line hardware and on-line software developments for the IBM 360/44 computer which will be used with the FSD to filter FSD data, are reported. The selected system configuration consists of the FSD on-line to the IBM 360/44 and the latter on-line to the IBM 7094 for the subsequent off-line computations. The on-line connection of IBM 360/44 and IBM 7094 computers will speed up the data input to the IBM 7094 computer for geometrical reconstruction and kinematic analysis. The selected configuration for the IBM 360/44 computer has a memory capacity of 65 K-bytes, i.e., 16000 32-bit words, a multiplexor channel with card reader and punch, printer and monitor disk, a high speed multiplexor channel with a high capacity disk, external interrupts, and direct data channel for on-line purposes. The analysis of the bubble chamber pictures with the system FSD-IBM 360/44 is divided into the following two steps: (1) an on-line processing with the FSD-IBM 360/44 system to compute from the FSD data, track points and glass fiducials; and (2) an off-line processing where the above data stored on the disk are transmitted in real time from the IBM 360/44 to the IBM 7094 (or another big computer) to be analyzed by the geometrical reconstruction and kinematics program. Discussed in detail are chain programs used to get track points and glass fiducials from the bubble chamber data. Advantages in the use of a small computer for on-line purposes are discussed. Also discussed are general advantages peculiar to the flying spot device analysis. S.C.W.

N67-36269# Max-Planck-Institut für Physik und Astrophysik, Munich (West Germany).
CURRENT STATUS OF THE MUNICH HPD SYSTEM
P. Freund, J. Laatsch, J. Schnecke, P. Seyboth, J. Seyerlein et al *In its* Programming for Flying Spot Devices Apr. 1967 9 p (See N67-36241 21-08)

Described is the continued development of hardware and test programs for the Munich HPD (Hough–Powell Device). S.C.W.

N67-36270# California Univ., Berkeley. Lawrence Radiation Lab.
THE SPIRAL READER—1966
J. Burkhard *In* Max-Planck-Inst. für Phys. und Astrophys. Programming for Flying Spot Devices Apr. 1967 13 p refs (See N67-36241 21-08)

Programming improvements and performance data for the spiral reader system are reported. The system is composed of four major parts: the logistics of supplying data to be measured to the spiral reader, the spiral reader, the off-line processing of data from the machine, and quality control. Major improvements to the spiral reader system have focused on the last three components of the system. Of these, emphasis has been on programming. The actual measuring rate was increased from the 85 two pronged events per hour reported in 1965 to over 110 events per hour on the same experiment as of 1966. This increase was due primarily to improvements in the on-line control program ACORN. Most of the work done on the spiral reader filtering program POOH focused on the reduction of time spent filtering, and the reduction of the reject rate. As in the on-line process, emphasis was on increasing the throughput of the system without sacrificing quality. Since 1965, the processing speed has been doubled. The present program is able to filter 2 pronged events at the rate of about 40 events per minute on a CDC 6600 as compared with 5/min in 1965 on an IBM 7094. This increase was achieved with very little machine language programming and by adaption of the program to the computer. In addition to many small adjustments in the program, significant improvement was achieved through the following changes: (1) the straightforward incorporation of event topology in the track matching phase; and (2) by allowing the program to retry certain classes of rejects with modified filtering parameters. S.C.W.

N67-36271# Massachusetts Inst. of Tech., Cambridge.
THE STATUS OF THE PEPR POINT GUIDANCE SYSTEM
Richard K. Yamamoto *In* Max-Planck-Inst. fuer Phys. und Astrophys. Programming for Flying Spot Devices Apr. 1967 21 p refs Sponsored in part by AEC (See N67-36241 21-08)

Major modifications to several programs in the PEPR point guidance system, preliminary results of production operation, and the present status of the system; are described. Discussed are software and hardware requirements, film positioning techniques, fiducial locating routines, clear point locating methods, and the track follower program. The point guidance system was operated on a production basis for a total of ~100 hours during the month of November 1966. The on-line computer then in use was a 65K PDP-1 and the film processed was that of the BNL 20" HBC (pp at 3.66 GeV/c). The event types measured were 2, 4, and 6 prong events as well as charged decay of neutral strange particles. The total number of events measured during the one-month period was ~1300 at an average rate of ~13 events/hr. Disregarding frame positioning and fiducial locating times, the rate was ~30/hr for good film. The yield for completely successful events ranged from 25% to 50%, depending on the quality of the film. The reliability of the bubble maps for ionization information was not checked quantitatively but qualitative studies on a limited number of tracks were made. Data looks promising; however, more detailed studies are necessary. Tests for systematic differences between PEPR-measured tracks and the corresponding hand-measured (Hermes measuring projectors) tracks were made on ~750 tracks. Results showed no outstanding systematic differences between PEPR and hand measurements. S.C.W.

N67-36272# Argonne National Lab., Ill.
THE POLLY SYSTEM FOR BUBBLE CHAMBER FILM MEASURING
Donald Hodges *In* Max-Planck-Inst. fuer Phys. und Astrophys. Programming for Flying Spot Devices Apr. 1967 10 p refs Sponsored by AEC (See N67-36241 21-08)

Described is a prototype and production version of the POLLY bubble chamber film measuring system that is under development at the Argonne National Laboratory. S.C.W.

N67-36273# Argonne National Lab., Ill.
THE USE OF INTERACTIVE GRAPHICAL CONSOLES IN BUBBLE CHAMBER FILM ANALYSIS
Robert K. Clark *In* Max-Planck-Inst. fuer Phys. und Astrophys. Programming for Flying Spot Devices Apr. 1967 14 p refs (See N67-36241 21-08)

Presented is a description of the production version of the POLLY system which focuses on design considerations used in the development of its operator console. Emphasized is the availability of the operator on-line (i.e., man–machine communication). S.C.W.

N67-36274# European Organization for Nuclear Research, Geneva (Switzerland).
PROGRESS WITH A MINIMUM GUIDANCE PROGRAM AT CERN AND RHEL
M. Ferran, J. Gerard, A. Head, G. Moorhead, J. Burren (Rutherford High Energy Lab., Chilton, Engl.) et al *In* Max-Planck-Inst. fuer Phys. und Astrophys. Programming for Flying Spot Devices Apr. 1967 37 p Prepared jointly with Rutherford High Energy Lab., Chilton, Engl. (See N67-36241 21-08)

Reported are continued efforts conducted under a program designed to: (1) develop an on-line data acquisition program which would make the appropriate scans, check the picture number, find the fiducials, and pack the HPD digitizings into arrays in preparation for the second phase; and (2) develop an off-line program which would then have semi-random access to the entire picture, and which would detect and follow tracks emanating from the rough

digitized vertex. Discussed is continuing progress in the development of the second program which is designated the minimum guidance or MG program. Described is the form of scan table data; the form of digitizings input to the MG program; and a hierarchical chart of the main routines of the MG program. The main operational building blocks making up the program are outlined. Preliminary performance data of the program in its incomplete state are presented, and sample data under analysis from different experiments in the 80 cm bubble chamber are discussed. S.C.W.

N67-36275# Illinois Univ., Urbana.
BUBBLE CHAMBER DATA PROCESSING SYSTEM FOR THE ILLIAC III COMPUTER
Bruce H. Mc Cormick and Fumiyo Uchiyama-Campbell *In* Max-Planck-Inst. fuer Phys. und Astrophys. Programming for Flying Spot Devices Apr. 1967 7 p (See N67-36241 21-08)

Described is the bubble chamber data processing system for the ILLIAC II computer which is built for processing pictures digitized in the raster mode. A special processor of the computer called the Pattern Articulation Unit, is used for this purpose. The remainder of the computer resembles a commercial arithmetic computer. The Arithmetic Unit and the Pattern Articulation Unit of ILLIAC III run in parallel. Automatic scanning and measuring can be attained regardless of the digitization format developed by the scanner, if the recognition program is provided. It is anticipated, however, that the FSD technique may be more efficient for one kind of experiment, and the PEPR technique for other experiments. In particular, the PERR method is superior to the FSD, which reconstructs tracks, bubble by bubble, for assaying the rough configuration of the picture. On the other hand, FSD can be more directly programmed to detect small angle scatterings, end points, etc. Chosen for development was a program that selects for each local area of the film the most appropriate choice of the four film digitization formats and its associated track element recognition procedure. Four distinctive algorithms will be used in the automatic scanning program being developed for the ILLIAC III one for each distinct mode of film digitization. The choice of scan/measure mode is optimally selected, depending upon the content of each locally scanned area. Data banks are shared in common. The functional flow chart for the proposed automatic scanning program QUADENT is illustrated, and the scanning parameters relevant for programming are listed. S.C.W.

N67-36276# Wisconsin Univ., Madison.
SIMULATION STUDIES WITH SATR
Murray A. Thompson *In* Max-Planck-Inst. fuer Phys. und Astrophys. Programming for Flying Spot Devices Apr. 1967 41 p (See N67-36281 21-08)

Reported are the design of a new form of automatic machine designated SATR (Stereo Analogue Track Recognition), and attempts to test the principles of the system by simulating the external 3D track recognition. Important features of SATR are: (1) the machine is intended to both automatically scan and measure and will not need human guidance or roads; (2) the machine will be able to analyze film with many crossing tracks and thus will allow better use of bubble chambers; (3) the machine will bypass the problems of scratches and dust on the film; (4) the machine will have a high accuracy and a low cost/frame; (5) the program is being written in Fortran; and (6) the output is a list of reconstructed tracks in three dimensions. General operating principles, computer specifications, programming specifications; and electronics requirements; are described. Although the total effort to develop this system has been 1-1/2 man years, the following have been confirmed: (1) the general principles work; (2) tracks can be followed through confused regions; (3) fiducials must be located accurately and should have arms at 45° to the scanning directions; (4) optical constants must be known accurately to allow multiple ray coincidence with good resolution; (5) ghost tracks formed by the false coincidences of rays to parallel tracks do occur but the coincidence density of these tracks is lower than in normal tracks; and (6) it is worthwhile increasing the 3D register length from 16 to 32 to help bridge the longer gaps. S.C.W.

N67-36277# Pennsylvania Univ., Philadelphia.
AUTOMATIC TRACK FOLLOWING PROGRAM AT THE UNIVERSITY OF PENNSYLVANIA
E. Bogart, H. Brody, S. Brooks, W. Churchill, S. Hagopian et al *In* Max-Planck-Inst. fuer Phys. und Astrophys. Programming for Flying Spot Devices Apr. 1967 16 p refs (See N67-36241 21-08)

Research focusing on the development and optimization of a completely automatic system for processing bubble chamber pictures using the HPD (Hough–Powell Digiziter) is reported. Of interest are $\pi^- - p$ interactions, and most specifically two and four prong reactions. Main features of the automatic track following (ATF) system which is under development are described, and plans for an off-line system of production are discussed. The programming system is written completely in Fortran except for trivial I/O and packing routines. Plotting techniqes used to improve the program are reviewed. Comparative data on 96 events which were measured both manually and by HPD and run through THRESH-GRIND are presented. Of the 96 events, 65 passed the ATF program in 2 or 3 views, for an efficiency of 70%. Of the 65 events submitted to THRESH, 50 passed, and 45 of these gave kinematic fits in GRIND, for a 70% efficiency. There were 46 events for which both AFT and manual measurements passed THRESH. Of these, 40 gave fits both from ATF and from manual measurements. In all cases the two methods gave fits to the same hypothesis. In addition, two manual events and one ATF event gave fits. It is noted that this general agreement in results for ATF as compared to manual shows up even more directly in comparisons of the missing mass. Plans to develop a subroutine to the program that will calculate the relative ionizations of outgoing particles; include a procedure that will test each segment for the existence of a king; predigitize the vertex; and extend the present pattern recognition system to the problem of tracks from 4-prong events are reviewed. S.C.W.

N67-36278# Brookhaven National Lab., Upton, N. Y.
TRACK FOLLOWING REVISITED
George Rabinowitz *In* Max-Planck-Inst. fuer Phys. und Astrophys. Programming for Flying Spot Devices Apr. 1967 9 p refs Sponsored in part by AEC (See N67-36241 21-08)

Reported is the development of a new track following program which was designed to improve the existing program used at Brookhaven National Laboratory. Notable differences between the two programs are outlined, and major components of the new program are described. Discussed are the steps involved in track initialization, the tracking routine, and the output format. The new program operates at about the same rate as the old program, i.e., at about 8000 digitizings per second. The number of track segments is reduced. Because of the data organization, output buffer overflows no longer occur. The new program is 1800 instructions long, compared to 5000 for the old version. The relatively simple logic makes program changes easier. The program is organized in such a way that to write it in Fortran should be straightforward. S.C.W.

N67-36279# Columbia Univ., New York.
CURRENT STATUS OF AUTOMATIC SCANNING AT COLUMBIA UNIVERSITY
D. Burd and R. Teitelbaum *In* Max-Planck-Inst. fuer Phys. und Astrophys. Programming for Flying Spot Devices Apr. 1967 35 p refs Sponsored in part by AEC (See N67-36241 21-08)

Continued research focusing on the development of an automatic scanning system for bubble chamber film is reported. Emphasized are attempts to maintain the generality needed to process film of varying characteristics with particular attention being

paid to the possibility of processing approximately one million triads of the stopping K^- run in the hydrogen bubble chamber. Described are studies of film properties, logical flow, track following, linking and merging of segments, and abstract tape and event recognition. S.C.W.

N67-36297# Sandia Corp., Albuquerque, N. Mex.
INSTRUCTIONS FOR USING THE CRAM COMPUTER CODE
Charles Watkins and Dermond Kelleher (N. Mex. Univ., Albuquerque) May 1967 36 p refs
(Contract AT(29-1)-789)
(SC-RR-150) CFSTI: HC $3.00/MF $0.65

Instructions are given for using the CRAM code, a computer program designed to solve multigroup diffusion equations in one and two dimensions. The system of interest is divided into a number of homogeneous mesh regions, and the equations are solved by finite difference techniques. NSA

N67-36540# Adelaide Univ. (Australia). Dept. of Physics.
A DIGITAL DATA-HANDLING SYSTEM FOR RECORDING VACUUM ULTRAVIOLET ABSORPTION SPECTRA
K. H. Lokan, G. N. Haddad, A. J. D. Farmer, B. R. Lewis, W. Fabian et al [1967] 19 p refs

A digital scanning system, designed for low attenuation absorption studies in the vacuum ultraviolet is described. This equipment, which is capable of handling up to four independent analogue or digital inputs, has been developed around a 400 channel multichannel analyzer. Facilities are provided for multiple scanning and direct output to a card punch to produce data in a form directly suitable for computer manipulation. The flexibility and performance of the system are illustrated by some experimental examples. Author

N67-36555 Royal Aircraft Establishment, Farnborough (England).
THE PUNCHED CARD INPUT SYSTEM FOR THE MERCURY COMPUTER
K. Sanderson, I. B. Piggott, and P. D. M. Thane Sep. 1966 74 p refs
(RAE-TR-66291)

The punched card input system for a digital computer is described. The treatment covers basic system characteristics, typical operation under program control, system logical design, and logical operation. Author

N67-36583# Library of Congress, Washington, D. C. Aerospace Technology Div.
COMPUTER TECHNOLOGY Surveys of Foreign Scientific and Technical Literature
Boris Doncov 31 Aug. 1967 30 p refs
(ATD-67-43; Rept.-10)

A collection of abstracted reports is presented which reviews Soviet developments in computer components, applications, and associated systems. Complete bibliographic information accompanies each item. A bibliography of the reports is also included. R.N.A.

09 ELECTRONIC EQUIPMENT

Includes electronic test equipment and maintainability; component parts, e.g., electron tubes, tunnel diodes, transistors; integrated circuitry; microminiaturization. For basic research see: 10 Electronics. For related information see also: 07 Communications and 21 Navigation.

N67-35307*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
ELECTRICAL, ELECTRONIC, AND FLUID DEVICES
Donald J. Vargo *In its* Aerospace Related Technol. Conf. for Ind. and Com. 25 May 1967 p 53-68 (See N67-35303 21-15)

Devices developed for aerospace application are described briefly. A photo-sensitive transistor as a vidicon tube substitute, a thyratron tube for operation in vacuum at 750°C, and a small portable computer are mentioned. Illustrations of power sources and propulsion systems are the Ni-Cd cell, the high energy/volume ratio AgZn battery, solar cells, and a pulse line capacitor for a plasma propulsion engine. Several controls and sensors are described, and include an arc control for detecting impurities in metals and semiconductors, a temperature control circuit for adjusting output voltage, a cold cathode ionization gauge to sense low pressures, and an infrared horizon sensor. Special mention is made of fluid amplifiers. N.E.N.

N67-35316* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
SCREENING TEST 12566 FOR COMMERCIAL POWER TRANSISTORS
K. N. Packard and V. R. Lalli Washington, NASA, 1967 23 p refs
(NASA-TM-X-52301) CSCL 09A

A screening test was conducted to measure the electrical parameters of commercial power transistors and select seven matched power transistors for use in the ATS power conditioning. Of the seventy-five power transistors tested, only twelve met the screening test requirements. These results represented a rejection rate of 83.8 percent and disclose the value of screening commercial parts prior to their use. Author

N67-35327# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.
STEP WIDTH MODULATED DC-TO-DC CONVERTER
C. F. Andren Apr. 1967 57 p refs
(Contract NOw-62-0604-c)
(TG-900; AD-654445)

A DC/DC converter was designed for use on a solar-cell, battery-powered satellite. The design uses step-width modulation rather than the more common pulse-width modulation for regulation. This report contains a description of the various forms of conversion and regulation which are currently in use and show why, for this application, step width modulation is best. The report also contains a complete description of the design of a particular converter included as a design example. Author (TAB)

N67-35329# Polytechnic Inst. of Brooklyn, Farmingdale, N. Y. Electrophysics Dept.
WIDE-ANGLE INTERNAL DEFLECTION STRUCTURES OF CATHODE-RAY TUBES Triannual Report, 1 Nov. 1966-28 Feb. 1967
Rudolf G. E. Hutter May 1967 36 p refs
(Contract DA-28-043-AMC-02449(E))
(PIBMRI-1355.2-67; ECOM-02449-2; Rept.-2; AD-654519)

A test gun is described which incorporates two-dimensional lens elements and allows dynamic deflection defocusing correction. Test results are given and conclusions are drawn leading toward the design of a gun capable of achieving the desired degree of reduction of deflection defocusing effects. Furthermore, two special electrostatic deflection systems are described for producing a rotationally symmetrical spot distortion, thus requiring dynamic correction of the rotational symmetrical electron lens only; this obviates the need for two-dimensional lenses. However, this method is feasible only for deflection in one direction. Author (TAB)

N67-35371*# Texas Instruments, Inc., Dallas. Semiconductor-Components Div.

DESIGN, DEVELOPMENT, AND DELIVERY OF 75-VA INTEGRATED STATIC INVERTER Final Report, Apr. 1965–Apr. 1967

Apr. 1967 137 p refs

(Contract NAS8-11925)

(NASA-CR-87988; TI-03-67-10) CSCL 09C

Circuitry, fabrication details, and overall performance characteristics of a 75-A static inverter are presented. The inverter is a 28-V dc to 3ϕ sine wave 400-Hz inverter which was designed for use as a gyro platform power supply. Also described are operational characteristics and fabrication details of the three integrated-circuit arrays and the two types of dual chip power transistors which were fabricated for the inverter. The inverter uses digital circuitry in developing the sine wave and for its regulation in order to achieve high efficiency. S.C.W.

N67-35403# General Electric Co., Schenectady, N. Y.

SHORT INTERACTION CROSSED-FIELD AMPLIFIER Quarterly Progress Report, 1 Dec. 1966–28 Feb. 1967

R. G. Lock and C. J. Truax Jun. 1967 40 p refs

(Contract DA-28-043-AMC-02268(E))

(ECOM-02268-3; QPR-3; Rept.-3; AD-654514)

The purpose of this study is to develop a novel, injected-beam non-re-entrant crossed-field amplifier employing a cycloiding electron beam. Fast bunching of the cycloiding beam occurs since the unfavorably phased electrons are collected on the sole as interaction with the RF field begins. The activity of the third quarter centered around constructing and testing a demountable amplifier, including the measurement of the cold loss of the interdigital circuit and the input-output match. Various incidental difficulties prevented operation of the amplifier. A cold loss of about 6.5 DB was measured for a line with molybdenum vanes and copper back wall. The RF window has a VSWR or = 1.2 and the coaxial-to-interdigital line transition has a VSWR or = 1.6. It was concluded that all copper slow-wave structures with greater back-wall spacing would be required in order to minimize the loss. Author (TAB)

N67-35404# Research Triangle Inst., Durham, N. C.

INTEGRATED SILICON DEVICE TECHNOLOGY. VOLUME XIV: INTERCONNECTIONS AND ENCAPSULATION

R. L. Beadles Wright-Patterson AFB, Ohio, AF Avionics Lab., May 1967 182 p refs

(Contract AF 33(615)-3306)

(ASD-TDR-63-316, Vol.XIV; AD-654630)

The elements of integrated device operations following the completion of all wafer processing are discussed. Specific emphasis is given to the separation of wafers into chips by scribing and breaking operations, to wire bonding and other contacting methods, to both conventional and unconventional packaging, and to the interconnecting of packages. The package interconnection discussion indicates major trends and problem areas and is not a comprehensive discussion of all of the many methods employed. From the generation of integrated device chips to their actual use in systems, procedures are in a continual flux due to their competitive nature and the methods are often derived from nontechnical considerations. This volume is, therefore, more a report on current practices than on the engineering and science of this subject area. Author (TAB)

N67-35415# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

EFFECTIVELY CONTROLLED PHASE-CONVERTERS (FERRITE PHASE CONVERTERS)

Yu. V. Yegorov 28 Feb. 1967 17 p refs Transl. into ENGLISH from Izv. Elektrotekh. Inst. (Leningrad), no. 47, 1962 p 73–85

(FTD-HT-66-391; TT-67-62284; AD-655031)

The paper deals with the case of a ferrite slab of arbitrary dimension located near any of the walls of a rectangular wave-guide, magnetized along an arbitrary axis, for an arbitrary wave propagation mode. The solution is obtained by the perturbation method, using the solutions of the unperturbed problem in the form of LSE and LSM modes, the behavior of which was investigated under the corresponding cases by the author earlier (Izvestiya LETI, No. 47, 1962). Allowance is made for the concentration of the field in the ferrite, which plays the decisive role in the theory of operation of efficient phase shifters. Simple formulas are proposed for the ferrite-slab calculations so as to ensure maximum utilization of this effect. The calculations are confirmed by experiment. The good agreement between the calculations and the experiment for the case of a single slab leads to the conclusion that the proposed calculation procedure is valid also for other ferrite structures with analogous physical phenomena. This applies also to the phase shifter of Reggia and Spencer (Proc. of IRE, v. 45, 11, 1957). TAB

N67-35438# Oak Ridge National Lab., Tenn.

LOW-NOISE WIDE-BAND CURRENT PREAMPLIFIER FOR USE WITH SEMICONDUCTOR DETECTORS

J. K. Millard and T. V. Blalock [1967] 6 p refs Presented at the Conf. on Semiconductor Nucl. Particle Detectors and Circuits, Gatlinburg, Tenn., 15–18 May 1967

(Contract W-7405-ENG-26)

(ORNL-P-3064; CONF-670520-2) CFSTI: HC $3.00/MF $0.65

A new low-noise wide-band current preamplifier was developed for use in fast-signal processing systems for semiconductor detectors (such as systems where gating operations are performed on amplified current pulses from a detector). This preamplifier consists of a single current-gain section with paralleled field-effect transistors in the input stage. The equivalent noise current of the preamplifier is about an order of magnitude below that of previously reported current preamplifiers of comparable bandwidth. The gain-bandwidth product of the preamplifier is 25 GHz. Author (NSA)

N67-35463# Block Engineering, Inc., Cambridge, Mass.

STUDY OF FAR INFRARED ATMOSPHERIC TRANSMISSIONS Final Report, 23 Mar. 1966–15 May 1967

Donald R. Smith 15 Jun. 1967 25 p refs

(Contract AF 19(628)-5979)

(AFCRL-67-0350; AD-654318)

The new General Electric Lucalox lamp has been investigated as a possible far infrared source. The Lucalox lamp was compared with both a 100 watt and a 400 watt mercury arc and an Osram lamp in the spectral region from 50 to 350 wave numbers. The mercury lamps and arcs prove to be superior light sources in the far infrared. It also is shown that a nominal behavior following the Raleigh-Jeans law is typical of both Osram lamps and mercury arcs in the far infrared. Author (TAB)

N67-35467# Bunker-Ramo Corp., Canoga Park, Calif. Defense Systems Div.

PLANAR COAXIAL INTERCONNECTION TECHNIQUES Quarterly Report, 1 Jan.–31 Mar. 1967

Howard L. Parks, William Griff, and Tom Kitaguchi Jun. 1967 83 p

(Contract DA-28-043-AMC-02024(E))

(ECOM-02024-4; QR-4; Rept.-4; AD-654422)

The research was directed toward the finalization of the techniques required to fabricate an exploratory development model. The vehicle is a propagation delay ring oscillator with various gating arrangements used to determine the transmission characteristics of a high-speed digital circuit under typical operating conditions. A thorough evaluation and establishment of the processes were accomplished. A study of the material requirements resulted in the selection of copper as the base metal for the coaxial structure because of its high purity, conductivity, and applicability for fabrication requirements. Investigation of dielectric materials provided two

avenues of approach including epoxy casting systems and use of molding compounds. Lamination techniques were explored utilizing a polyamide-epoxide bonding system for final assembly of the vehicle. Process implementation procedures are prescribed detailing the stages of fabrication of the exploratory development model. Further optimization will be required for supplementary applications including through-hole plating techniques and methods for attachment of integrated circuits. The effectiveness of termination is exposed by displaying the waveforms under both terminated and unterminated conditions. Author (TAB)

N67-35486# Texas Univ., Austin. Labs. for Electronics and Related Science Research.
ANALYSIS OF DISTRIBUTED AMPLIFIER STRUCTURES Interim Scientific Report
Randolph C. Matson and Cyrus O. Harbourt 24 May 1967 86 p refs
(Grant AF-AFOSR-766-67)
(AFOSR-67-1230; TR-34; AD-655080)

The research includes an analysis of the stability requirements and an evaluation of feasible configurations for linear solid-state distributed amplifiers. In particular, the structures considered may have one or more negative parameters. The models investigated are divided into reciprocal and non-reciprocal types. Sufficient conditions for stable amplification are derived from a network model. The results show that for passive terminations, the characteristic impedance of a reciprocal transmission line must not have a negative real part for right half-plane frequencies. For amplification with distance down the line, the real part of the propagation constant must be negative. A line length is determined from the magnitude of the loop gain expression such that reflections at the terminations will not saturate the structure. For optimum gain, the line and load must be matched. Parameter tolerances are shown to complicate the matching of this reciprocal model and the load. Author (TAB)

N67-35488# Navy Electronics Lab., San Diego, Calif.
BROADBAND MEDIUM-POWER RADAR DUPLEXER Research and Development Report, 17 Aug. 1965–Oct. 1966
D. R. Wehner and M. H. Mott 17 Apr. 1967 29 p refs
(NLE-1454; AD-654903)

Describes the development of a duplexer that combines PIN-diode active switching and a four-port coaxial circulator. The unit has a power capability of 250 watts average and 10 kilowatts peak, can handle antenna mismatches up to two to one, and has a recovery time of about 1 microsecond. Author (TAB)

N67-35491# Radio Corp. of America, Somerville, N. J. Defense Electronics Products.
HIGH PERFORMANCE THIN FILMS FOR MICROCIRCUITS Quarterly Report, 1 Dec. 1966–28 Feb. 1967
F. Huber, W. H. Laznosky and W. Witt Jun. 1967 23 p
(Contract DA-28-043-AMC-01230(E))
(ECOM-01230-8; Rept.-8; QR-8; AD-654782)

Thin-film hafnium-hafnium-dioxide capacitors have been fabricated on silicon substrates, and mounted and encapsulated in TO-5 cans. The temperature coefficient of capacitance can be as low as +50 ppm/C (up to 350 C) and seems to be smaller than that of thin-film hafnium-hafnium-dioxide capacitors, nonencapsulated, and deposited on passive substrates. Additional measurements will be performed to obtain more information on the TCC. During the fabrication of P-channel MOS transistors with HfO2 gate insulators, difficulty has occurred in complete anodization of the metal film over the channel region. For this reason the resistance between source and drain electrode is always low. Additional N-channel HfMOS transistors have been fabricated and tested at different temperatures. The pinch-off voltage increases with increasing temperature in these depletion-type units. Life tests of encapsulated hafnium-hafnium-dioxide capacitors show no significant change with time (2000 hours). The rate of anodization of purer hafnium films is being re-examined. Author (TAB)

N67-35545# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
RF PULSE-AMPLITUDE FLIP-FLOP BASED ON TUNNEL DIODES
I. Ye. Golberg, G. P. Zemtsov, and L. I. Telyatnikov 24 Feb. 1967 7 p Transl. into ENGLISH from Russian Patent No. 178169 (Appl. No. 880596/26-24, 8 Feb. 1964) 2 p
(FTD-HT-66-791; AD-654654)

A rf pulse-amplitude flip-flop based on tunnel diodes which has the distinguishing feature that, for the purpose of assuring decoupling between the input and output and simplification of the logic circuits, it contains two inductances which form two tank (oscillation) circuits, two tunnel diodes connected in sequence according to the feed circuit, and a blocking capacitor separating the oscillation circuits according to high frequency. A flip-flop in accordance with that mentioned above which has the distinguishing feature that it contains one inductance connected in between the input and output and separating the tunnel diodes according to high frequency. TAB

N67-35555# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
COMPLEX WAVEGUIDE SYSTEMS
N. L. Kogan, B. M. Mashkovtsev, and K. M. Tsibizov 12 Apr. 1967 314 p refs Transl. into ENGLISH of the book "Slozhnyye Volnovodnyye Sistemy" Leningrad, 1963
(FTD-MT-64-366; AD-655040)

The book discusses the theory of complex waveguides with variable cross sections and circular waveguides containing irregularities. External parameters of waveguide circuit elements are defined and equivalent circuits explained. Wave matrices and their connections in waveguide multiterminal networks are described. Calculations of flat-lateral irregularities, filters, ring and slit waveguide coupling rotation joints, antenna switches, and systems containing ferrites are given. Specific methods based on the wave characteristics of rapidly varying fields for calculating electrical parameters are used. TAB

N67-35556# Varian Associates, Palo Alto, Calif.
STUDY OF METHODS TO IMPROVE HIGH POWER KLYSTRON LIFE AND RELIABILITY Quarterly Report, 1 Jan.–31 Mar. 1967
John Brookshier Ft. Monmouth, N. J., Army Electron. Command, May 1967 37 p
(Contract DAAB07-67-C-0228)
(ECOM-0228-1; Rept.-346-1Q; QR-1; AD-654779)

Studies have been conducted in the following areas: (1) Cathodes have been constructed for testing as follows: Three cathodes have been tested in a vacuum bell jar where their operation could be observed. After 1,000 cycles of 30 minutes on and 30 minutes off, there were no heater failures; however, there were some mechanical changes. Three diodes were placed on dc cycling for 1,000 cycles of 30 minutes on and 30 minutes off. One of these was removed because of a vacuum leak. Three cathodes were placed in a bell jar where they could be observed. These operated at 20% over normal power. Three diodes were placed on noncycling or normal operational life with an ac voltage applied. Three diodes are on normal life with dc voltage applied. Structural changes have been proposed for future diode and bell jar cathode tests. (2) The window study consisted of the construction of the following items: (a) Pulse generator for instigating arcs in the waveguide. (b) An adapter for three point viewing of a photomultiplier tube. (c) A three-port viewing waveguide assembly for measuring the speed of an arc. (d) A remote turnoff section to stop the arc. Equipments were also modified to reduce the drive level to preset

values so the arc formed could travel at reduced powers. In order to minimize problems during these preliminary tests, the VA-876 was set aside, and tests were made using a Varian-owned amplifier. This Varian-owned klystron will produce 8 kW at 10.5 GHz and was used to debug the system before proceeding to the VA-876 at higher power levels. Author (TAB)

N67-35559# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
CATHODE-RAY TUBE [ELEKTRONNOLUCHEVAYA TRUBKA]
Yu. A. Titov 24 Feb. 1967 6 p Transl. into ENGLISH from Russian Patent No. 170742 (Appl. no. 881944/26-24, 12 Feb. 1964) 2 p
(FTD-HT-66-722; AD-654648)

A cathode ray tube with a flat beam is described. The device contains a memory target for visual presentation of parallel binary codes. This memory target is made up of mutually insulated conducting strips and a luminescent screen. TAB

N67-35583# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.
A HYBRID DC OPERATIONAL AMPLIFIER
R. L. Konigsberg 25 May 1960 41 p refs
(Contract NOrd-7386)
(APL/JHU-CF-2868; AD-654423)

The report describes an experimental DC operational amplifier intended for missile control circuit applications where severe environments are encountered. It employs (1) duo-triode subminiature vacuum tube and (8) transistors, embodies the Goldberg principle for correction of DC misalignment. Design details, measured characteristics and a schematic are presented. Author (TAB)

N67-35586# Army Electronics Labs., Fort Monmouth, N. J.
INVESTIGATION OF SOLID-STATE TRAVELING-WAVE AMPLIFIER
Joseph S. Nadan Feb. 1967 35 p refs
(ECOM-2802; AD-654342)

The report covers an investigation which was conducted to determine the feasibility of a solid-state traveling-wave amplifier. This device consists of an n-type semiconductor in which drifted carriers interact with a slow electromagnetic wave. Methods for characterizing the material are presented. The propagation matrix for the material is derived, including the effects of diffusion and particle-lattice collisions. The thin-film, slow-wave structure is studied. The dispersion equation of a stub-loaded meander line is derived, revealing usable frequencies at which the phase velocity is low and the interaction or coupling impedance is high. Results of fabrication of the slow-wave structure are outlined. Author (TAB)

N67-35605 Joint Publications Research Service, Washington, D. C.
TRANSLATIONS ON COMMUNIST CHINA: SCIENCE AND TECHNOLOGY, NO. 383
27 Jun. 1967 34 p refs Transl. into ENGLISH from Tien-Tzu Chi-Shu (Shanghai), no. 8, 8 Aug. 1964
(JPRS-41564; TT-67-32197) CFSTI: $3.00

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N67-35606 Joint Publications Research Service, Washington, D. C.
PRELIMINARY ANALYSIS OF RADIO COMPONENT RELIABILITY
I-an Li *In its* Transl. on Communist China: Sci. and Technol., No. 383 27 Jun. 1967 p 1–11 refs (See N67-35605 21-09)

Foreign literature on radio component reliability is reviewed. Factors in component damage are identified as engineering design, operation, manufacture, and miscellaneous. Only the most conventional components are considered, and these include solid carbon resistors, carbon diaphragm resistors, winding resistors, potentiometers, and capacitors. Tropical weather, desert weather, cold zone weather, upper atmosphere weather, and mechanical environment conditions are investigated. Production automation and miniaturization are briefly discussed as means of increasing component reliability. N.E.N.

N67-35607 Joint Publications Research Service, Washington, D. C.
THE CONSTRUCTION OF ALUMINUM ELECTROLYTIC CAPACITORS
Lin-hsiang Hwu, Wen-an Kang, and Yu-chun Chiang *In its* Transl. on Communist China: Sci. and Technol., No. 383 27 Jun. 1967 p 12–29 (See N67-35605 21-09)

The processes and mechanism of capacitor construction are briefly described. Aluminum anode purification and effective surface area enlargement are discussed, and the mechanism and process of anodic coating are outlined. Core winding is covered, and the preparation and work function of electrolytes are mentioned. Problems associated with assembling, aging, testing, and storage are indicated. N.E.N.

N67-35610# Research Triangle Inst., Durham, N. C.
INTEGRATED SILICON DEVICE TECHNOLOGY. VOLUME XV: RELIABILITY
C. D. Parker May 1967 85 p refs
(Contract AF 33(615)-3306)
(ASD-TR-63-316,Vol.XV; AD-655082)

Although some variations in reported failure rates result from a lack of standard conditions, the variations principally result from a difference in process control among manufacturers. Most failures result from surface-related failure mechanisms and interactions between the interconnection system materials. Of several interconnection systems that are in use, gold wire ball bonded to aluminum metallization is the most frequently used and is considered the most reliable at temperatures below 125C. Two promising alternatives are the aluminum metallization-aluminum wire system and the molybdenum-gold metallization-gold wire system. Either of these could eventually prove to be the more reliable. Temperature accelerates most failure mechanisms and failure rates are usually stated at specific temperatures. Reverse biased junctions accelerate surface mechanisms and increased current accelerates bulk failure mechanisms. It is generally agreed that failure rates increase by approximately a factor of 10 between 25 and 125C. Acceleration factors have not been estimated for stresses other than temperature. Screening techniques contribute significantly to the reliability of integrated circuits by eliminating potential failures from actual use. Drop outs from burn-in screening tests run several percent of a starting lot. TAB

N67-35619# Hughes Aircraft Co., Culver City, Calif. Aerospace Group.
INVESTIGATION OF STIMULATED RAMAN OSCILLATORS AND AMPLIFIERS Final Report
D. P. Borfeld, E. R. Peressini, and W. R. Sooy May 1967 85 p refs
(Contract DA-31-124-ARO(D)-202)
(P67-81; AROD-4408-5-P; AD-654429)

The results of an investigation of several non-linear optical effects are presented. Main emphasis is on the study of stimulated Raman scattering and mode selective techniques for giant pulse lasers. Secondary studies of optical harmonic generation and bleachable dye lasers are also discussed. It is shown that the gain in a diffusely pumped stimulated Raman scattering amplifier

behaves according to the theory developed by Hellwarth and that the gain anomaly observed in colinear amplifiers (and explained as a consequence of beam trapping of the input beam) is, in fact, not present. A study of the mode selective properties of a passive Q-switch reveals that mode selection occurs as a result of the slow buildup of oscillation in a passive Q-switched laser. The character of spatial and temporal amplitude fluctuations in a laser beam is related to the degree of mode selection employed and the effect of these fluctuations on stimulated Raman conversion is given. A discussion is presented of laser action in two polymethene dyes in glycerol solution pumped by a giant pulse ruby. The potential for laser action in these particular dyes was identified in a parallel Hughes program. Author (TAB)

N67-35627# ITT Federal Labs., Nutley, N. J.
RUGGEDIZED CABLE ASSEMBLY FOR PCM EQUIPMENT Final Report, 8 Sep. 1964–31 Dec. 1966
Charlotte F. Engler and Robert G. Leef Jun. 1967 179 p
(Contract DA-28-043-AMC-00354(E))
(ECOM-00354-F; AD-654521)

Report summarizes engineering processes to improve cable assembly CX-4245/G. Working to a specified weight limitation, cable with improved shielding effectiveness and greater breaking strength and an entirely new hermaphrodite connector were developed. The rigors of field service were a major influence on the design and worked in opposition to the weight and electrical requirements. The first cable and connector models conformed with most of the specified requirements in laboratory tests. One cable had a steel wire rope support and the other cable a steel wire braid support. Both had required shielding improvement in terms of surface transfer impedance. In field tests both designs had inadequate shielding effectiveness and the steel wire rope design exposed the electrical components to mechanical damage. Both lacked ruggedness due to designing for minimum weight and size. The steel wire rope design was abandoned. The steel braided design was revised for greater ruggedness and a model was produced that met weight and strength requirements. A prototype assembly using connectors with interchangeable internal parts permitting variation of shield interconnections was field tested. An arrangement with all shield braids insulated was selected. 100 CX-11230 assemblies were produced as Service Test Models consisting of one-half mile of cable type A2321536 (ITTFL) with connector CA-44317 (ITT Cannon) on each end delivered on a type DR-7(modified)reel. Author (TAB)

N67-35644*# Watkins-Johnson Co., Palo Alto, Calif.
DEVELOPMENT OF A 10 WATT S-BAND TRAVELING-WAVE TUBE Quarterly Progress Report
L. A. Roberts and M. V. Purnell 14 Apr. 1967 26 p ref
Prepared for JPL
(Contracts NAS7-100; JPL-951299)
(NASA-CR-88023; QPR-1) CFSTI: HC $3.00/MF $0.65 CSCL 09A

Progress is reported on the development of a 100 watt, 55 percent efficiency, 2.3 GHz traveling-wave tube for space applications. Program plans and schedules were laid out, tube designs were completed and materials were ordered. Design of the electron gun was completed, a gun was constructed and the beam profile was measured in the gun testing equipment. Preliminary electrical tests of the helix structure were made and design decisions were made on the helices for initial tubes. Various mechanical details of the tube were decided and assembly procedures worked out. This report gives the details of the design and construction decisions that were made. Author

N67-35693# Air Force Cambridge Research Labs., Bedford, Mass. Solid State Sciences Lab.
ANALYSIS AND DESIGN OF MAXIMUM-GAIN, LOW-CURRENT JUNCTION FIELD EFFECT TRANSISTOR CONFIGURATIONS
B. Buchanan, S. Roosild, and R. Dolan Mar. 1167 47 p refs
Its Phys. Sci. Res. Paper No. 318
(AFCRL-67-0184; AD-654308)

Representative types of junction field effect transistor (JFET) configurations are analyzed on a qualitative comparative basis to determine the JFET configuration with the largest gain. Experimental results are presented on a small current amplifying device (SCAD) whose design is based on this determination. Author (TAB)

N67-35696# Rome Air Development Center, Griffiss AFB, N. Y. Reliability Branch.
ANALYSIS OF INTEGRATED CIRCUIT PACKAGE INTEGRITY USING HELIUM LEAK DETECTION TECHNIQUES Final Report
Edgar A. Doyle, Jr. May 1967 79 p refs
(RADC-TR-67-52; AD-654695)

Current integrated circuit packaging techniques, a compilation of applicable package hermeticity testing techniques, and the required theoretical fluid flow background necessary to evaluate integrated circuit package integrity, are presented. The basic types of integrated circuit packages are described with the emphasis placed on defects in package construction and hermetic sealing techniques which can influence package integrity. A general description of standard hermeticity tests is given, and their inherent limitations, when used in determining integrated circuit package leak rates, are discussed. The helium leak detection system and test procedures for package leak rate measurements (dV/dt-std.cc/He/sec.) are described. A complete review and analysis of the classical steady state helium gas flow rate equations are given. The time dependence corrections to the classical flow laws, required when an enclosed volume (e.g. and IC flat pack) is imposed on the system are derived and applied to the helium leak detection technique. The analysis includes a detailed determination of equivalent hole diameters based on the measured package leak rate. The importance of obtaining a hermetically sealed package with reference to integrated circuit reliability is then discussed. In the classical steady state gas flow analysis, the derivation of the free-molecular flow rate law is noteworthy. The specific approach taken in deriving this gas flow rate law allows a determination of the variation in the molecular flow rate magnitude at points within a cross-sectional plane of a cylindrical tube. Author (TAB)

N67-35700# California Inst. of Tech., Pasadena. Synchrotron Lab.
INJECTION TIMING AND RF CONTROL SYSTEM CALTECH 1.5 GeV ELECTRON SYNCHROTRON
J. H. Marshall (Analog Technol. Corp.), J. O. Maloy, and J. H. Mullins Nov. 1966 62 p
(Contract AT(11-1)-68)
(CALT-68-109) CFSTI: HC $3.00/MF $0.65

The electronic system used to control the injector and the radio frequency accelerating voltage of the CalTech Electron Synchrotron is described. The present solid-state system (1964–1965) replaces a vacuum-tube system which had been used since 1956. NSA

N67-35717# Georgia Inst. of Tech., Atlanta. Engineering Experiment Station.
QUARTZ CRYSTAL AGING EFFECTS Final Report, 15 Feb. 1965–15 Feb. 1967
Richard B. Belser and Walter H. Hicklin Jun. 1967 101 p
(Contract DA-36-039-AMC-02251(E))
(ECOM-02251-4; SR-4; AD-654784)

Aging studies of about 300 quartz resonators in the frequency range 81.9 kHz to 30.0 MHz stored at 85C were made. Frequency measurements of one group of 10 MHz units stored at 125C were performed. The 3 MHz units with conventional electrodes and the 5 MHz units with both conventional and annular electrodes were mounted and sealed in HC-27/U glass holders. In addition, approximately 35 units were mounted in holders sealed by cold

welding. Frequency spectra and x-ray topographic analyses were made of units plated with conventional and with annular electrodes. Author (TAB)

N67-35784# Texas Univ., Austin. Labs. for Electronics and Related Science Research.
COMPUTER MODELS OF THE FIELD-EFFECT TRANSISTOR Interim Report
Ben David Roberts, Jr. and Cyrus O. Harbourt 19 Apr. 1967 80 p refs
(Grant AF-AFOSR-766-67)
(TR-33; AFOSR-67-1336; AD-654697)

Network analysis programs may be used to analyze complex electronic circuits. This requires that models for the active devices in these circuits be developed. A nonlinear model of the field-effect transistor is presented for use in large-signal applications. From this model several piecewise-linear models suitable for use with Electronic Circuit Analysis Program (ECAP) are derived. The approximations required in these models are evaluated, and models intended for use in pulse inverters and choppers are presented. Techniques for measuring the parameters in the models are described and results of the measurement of these parameters for a sample of field-effect transistors are given. Finally, the behavior of a sample of these devices in pulse inverter and chopper circuits is compared to the behavior of the device models in computer simulation of the circuits. Author (TAB)

N67-35786# Research Triangle Inst., Durham, N. C.
INTEGRATED SILICON DEVICE TECHNOLOGY. VOLUME XVI: FUNCTIONAL DESIGN
J. N. Brown May 1967 271 p refs
(Contract AF 33(615)-3306)
(ASD-TDR-63-316, Vol. XVI; AD-655083)

The design of silicon monolithic integrated circuits is discussed. The second and third major sections are concerned with general aspects of integrated circuit technology and the design and characteristics of both passive and active integrated components. These two sections are intended primarily for those individuals who are not familiar with integrated circuit concepts. Factors such as the desirability and ease of employing relatively large numbers of active devices, matched components, resistance ratios and temperature and voltage compensation in integrated circuits are discussed. The fourth section is a discussion of digital integrated circuits. Different logic types are compared and the design of single gates as well as more complex digital circuits and systems are considered. Analog circuit design is discussed in the last section. One of the major objectives of this section is the presentation of methods for eliminating the need for inductance and large-value capacitance in integrated circuits. Unconventional approaches to designing frequency selective circuits and desensitized circuits are also covered. Author (TAB)

N67-35860# Sylvania Electric Products, Inc., Woburn, Mass. Semiconductor Div.
IMPROVE K_a MIXER DIODES FOR USE IN ECM FREQUENCY CONVERTERS Quarterly Report, 1 Feb.–30 Apr. 1967
S. E. Howe and J. E. Sherpey 30 Apr. 1967 29 p
(Contract NObsr-93103)
(QR-6; AD-654207)

The test equipment setup for performance of the specified characteristic and power aging tests has been completed. Preliminary results have been obtained regarding determination of correlation between the effect of Ka- and X-band power upon the devices. Experimental lots of semiconductor material have been processed covering a range of characteristic properties. Sample devices have been assembled from the experimental lots. Preliminary measurements of conversion loss at the specified 85 milliwatt power level show a reasonable number of units below the objective 6.0 db maximum limit in the one lot tested. Author (TAB)

N67-35867# Watkins-Johnson Co., Palo Alto, Calif.
INVESTIGATION OF LOW WEIGHT FOCUSING SCHEMES FOR TRAVELING-WAVE TUBE AMPLIFIERS Quarterly Report, 15 Oct. 1966–14 Jan. 1967
J. N. Nelson Feb. 1967 25 p
(Contract DA-28-043-AMC-02578(E))
(ECOM-02578-2; QR-2; AD-655001)

The report describes the results on a program concerned with the development of a 3 dB noise figure, 4 pound, X-band low-noise TWT amplifier. A noise figure of 6.2 dB has been achieved with a solid beam tube focused in an 800 gauss SRPM, weighing less than 3 pounds. A miniature 700 gauss Alnico 8 SRPM has been fabricated which weighs less than 2 pounds. Further experiments are underway with solid beam SRPM tubes, and we expect to achieve noise figures less than 6.0 dB over the 8.0 to 10.0 frequency range during the next quarter. Two hollow beam tubes have been designed and fabrication initiated. The first design employs a miniature Alnico 9 PM focusing assembly. This magnet weighs less than 3 pounds and provides a peak field in the cathode-electron gun region of 1400 oersteds. The second hollow beam tube is designed to be focused in an SRPM. It will be used to investigate the collapsing effect of an annular beam as the beam passes through a magnetic field reversal. Author (TAB)

N67-35870*# Watkins-Johnson Co., Palo Alto, Calif.
DEVELOPMENT OF A 100 WATT S-BAND TRAVELING-WAVE TUBE Quarterly Report
L. A. Roberts and M. V. Purnell 21 Apr. 1967 25 p Prepared for JPL
(Contracts NAS7-100; JPL-951299)
(NASA-CR-88022; QR-2) CSCL 09A

Progress is reported on the development of a 100 watt, 55 percent efficiency 2.3 GHz traveling-wave tube for space applications. Three tubes were designed as simple, single helix tubes to work out the basic electrical, mechanical, and beam focusing problems. In addition, RF performance evaluations were made to determine if the performance correlated with design calculations. The evaluation of the third tube was not completed but its performance has shown up to 120 watts power output. Detailed RF performance characteristics for the three tubes are given. The test vehicle for the high efficiency studies has essentially been established. Author

N67-35884# Research Triangle Inst., Durham, N. C.
INTEGRATED SILICON DEVICE TECHNOLOGY. VOLUME XIII: INTRACONNECTIONS AND ISOLATION
R. P. Donovan May 1967 168 p refs
(Contract AF 33(615)-1998)
(ASD-TDR-63-316; Vol. XIII; AD-655081)

The volume discusses methods of coupling and decoupling elements on a silicon block according to a conventional schematic diagram. The conducting paths in an integrated circuit can be realized by a variety of methods such as bulk paths, diffused channels, jumper wires, mixed conducting slurries or deposited metals. The latter is by far the most important. Such deposited metals are usually adequate for making ohmic contacts to silicon as well. Isolation of elements in an integrated circuit is also accomplished by a variety of methods, the most effective of which are the various dielectric isolation methods. Dielectrics used include silicon oxide, silicon nitride, silicon carbide and air. Other techniques, relying on reverse biased junctions and bulk resistances, are adequate for many applications and are easier to fabricate. Reverse biased junctions are the most common isolation method employed in production-type integrated circuits. Author (TAB)

N67-35910# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. for Nuclear Problems.
ANALYSIS OF A CHARGING DEVICE FOR AN AMPLITUDE CODER OF HIGH ACCURACY [ANALIZ ZARYADNOGO USTROISTVA AMPLITUDNOGO KODIROVSHCHIKA POVYSHENNOI TOCHNOSTI]
B. Yu. Semanov 1967 34 p refs In RUSSIAN
(JINR-P13-3275)

The problems concerning the dynamics of a charging device with a negative feedback are considered. Simple expressions of a good approximation are obtained for transfer functions: of separate cascades, open and closed systems, and of a device as a whole. The stability and the transient response are analyzed. Theoretical calculations are proved by numerical examples and by experiment. Author (NSA)

N67-35924# Picatinny Arsenal, Dover, N. J. Engineering Sciences Lab.
LINVILL MODELING OF DISTRIBUTED DEVICES
Myron Allen Jun. 1967 20 p refs
(PA-TR-3525; AD-654981)

The Linvill model for distributed devices is described and its application to the low-, moderate-, and high injection phenomena occurring in the transistor base region is discussed. Use of the Linvill model is first illustrated in terms of the one-dimensional diode; how the treatment can be extended to the transistor is then indicated. The version of the Linvill model used in this report is generalized to include the drift and diffusion effects of both majority and minority carriers. Author (TAB)

N67-35947# Technische Hochschule München (West Germany). Fakultaet fuer Maschinenwesen und Elektrotechnik.
THE BACKGROUND NOISE OF COOLED PARAMETRIC REFLECTION AMPLIFIERS WITH CAPACITY DIODES [DAS RAUSCHEN GEKUEHLTER PARAMETRISCHER REFLEXION-SVERSTAERKER MIT KAPAZITAETSDIODEN]
Kurt Garbrecht (Ph.D. Thesis) 1966 197 p refs In GERMAN

Background noise in a cooled parametric amplifier is attributed to bulk resistance heating caused by decreased diode performance. Static variations in barrier capacity and pump oscillator do not effect the semiconductor performance markedly. Cooling of the amplifier with helium (or nitrogen) resulted in a noise temperature of 29°K. Transl. by G.G.

N67-35960# Army Electronics Labs., Fort Monmouth, N. J.
THIN-FILM SHIELDING MEASUREMENTS
Robert A. Weck and Carl J. Lump Jan. 1967 18 p refs
(ECOM-2798; AD-654781)

The report presents the results of plane wave shielding effectiveness tests on vacuum-deposited metallic thin films. The test data is presented in graphical form for thin films of copper, aluminum, silver, gold, and nickel. Shielding effectiveness as high as 90 db was obtained. Discrepancies between theoretical values and laboratory data are discussed and suggestions are made for further work. Author (TAB)

N67-35977 Atomic Energy Establishment, Winfrith (England). Control and Instrumentation Div.
DIRECT COUPLED AMPLIFIERS USING FIELD EFFECT TRANSISTORS
E. P. Fowler 1965 12 p
(AEEW-M-521) HMSO: 1s 9d

One application is described of the field effect transistor (FET) in which the combination of low voltage drift and relatively low input leakage current are necessarily used together. An investigation was conducted on the characteristics of some fourteen devices to see whether those with very different characteristics can still be used or whether selection is necessary or desirable. It is evident that the characteristics of the FET are amenable to simple calculation to a far greater extent than is the case with the duo-junction transistor. Pertinent schematics on various amplifiers are included. R.LI.

N67-35999*# Varian Associates, San Carlos, Calif. Eimac Div.
ESFK 20-100 WATT S-BAND AMPLIFIER
Erling L. Lien and Albert Mizuhara Apr. 1967 37 p Prepared for JPL
(Contracts NAS7-100; JPL-951105)
(NASA-CR-88116; QR-1) CFSTI: HC $3.00/MF $0.65 CSCL 09A

An electrostatically focused klystron having a radiation-cooled depressed collector for use in interplanetary spaceborne communication systems is presently under development. Although two klystrons have been built in the past which satisfied the power output and bandwidth (30 MHz at the −3 db points) requirements, the highest efficiency achieved was 38 percent at the 100 watt level—lower than the 45 percent required. The design of a five-resonator, narrow-band klystron, fabricated primarily to investigate the various efficiency improvement schemes is described. Small-signal gain calculations showed that a total of five resonators were required. Presented in graphical form are the operating characteristics of the klystron such as rf efficiency and beam transmission as a function of the load conductance of the output resonator normalized to the beam conductance. Author

N67-36004# Sandia Corp., Albuquerque, N. Mex.
DESIGN OF A SPECIAL OIL-INSULATED HIGH-VOLTAGE PULSE TRANSFORMER
C. E. Spencer and P. L. Kerley May 1967 13 p
(Contract AT(29-1)-789)
(SC-TM-67-208) CFSTI: HC $3.00/MF $0.65

The design, performance, and construction of a small high-voltage pulse transformer that uses oil instead of epoxy for an insulating medium is described. The transformer uses a multilayer secondary with a 21:1 stepup ratio to generate 150-kilovolt, 15-microsecond pulses into a 10-kilohm load at repetition rates of 10 pulses per second. The transformer was built for use with the British K Type 1 neutron tube for use under water next to the fueled core of a Godiva-type reactor to determine reactor parameters. Author (NSA)

N67-36020# Laboratory for Electronics, Inc., Boston, Mass. Applied Research Dept.
RESEARCH IN FERROMAGNETICS, PART II Final Report, Apr. 1965–Mar. 1966
Robert J. Spain, Claude P. Battarel, Harvey I. Jauvtis, Michael J. Marino, and Patrick J. Peoples Feb. 1967 109 p refs
(Contract AF 19(628)-4197)
(AFCRL-67-0205; AD-655059)

Work was carried out on ascertaining the feasibility of a DTPL Push Down List Memory. Investigations were made of the basic PUDL thin film shift register structure as well as the associated conductor patterns. Drive and sense electronics have been designed and breadboarded and a number of system designs have been studied and evaluated. Additional work is still required for the optimization of the thin film elements and for the completion of the feasibility model. Author (TAB)

N67-36031*# Westinghouse Electric Corp., Pittsburgh, Pa. Research Labs.
DESIGN AND FABRICATION OF AN ANALOG VOLTAGE TO DUTY CYCLE GENERATOR Interim Progress Report
Apr. 1967 28 p refs Prepared for JPL
(Contract NAS7-100; JPL-951306)
(NASA-CR-88129; IPR-4) CFSTI: HC $3.00/MF $0.65 CSCL 09A

Progress is reported on the development of an integrated circuit form of a circuit which converts a variable low power level

dc signal to a digital output such that the digital output on time portion of the cycle is proportional to the dc input signal magnitude. The design review was continued and an analysis of the operational amplifier circuit allowed a reduction in the number of active components. The field of tantalum thin film technology was thoroughly surveyed along with the factors affecting the stability of tantalum components. The possibility of using tantalum nitride instead of the oxide was also considered. R.N.A.

N67-36092# Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik.
A CATHODE RAY TUBE AS FAST MULTIPLIER WITH HIGH INPUT RESISTANCE [EIN KATHODENSTRAHLROHR ALS SCHNELLER VIELFACHSCHALTER MIT HOHEM EINGANGSWIDERSTAND]
Klaus Weigele Feb. 1967 21 p refs In GERMAN; ENGLISH summary
(KFK-552)

A multiple switch was developed, by means of which numerous high impedance sources (e.g. capacitances) can be scanned by an electron beam for both positive and negative voltages. The model described has nine input channels having input impedances between 10^{11} and 10^{12} ohms if the switch is off. Scanning of each channel takes about 100μsec. Positive voltages up to 10 V and higher and negative voltages up to about -2V can be transferred linearly. Several improvements are discussed. Author (NSA)

N67-36163# Army Electronics Labs., Fort Monmouth, N. J.
USE OF THE CAPACITANCE-VOLTAGE METHOD FOR INVESTIGATING MOS STRUCTURES
Herbert L. Mette Apr. 1967 29 p refs
(ECOM-2821; AD-654343)

The report is intended as a guide in the application of the capacitance-voltage method for determining the electronic properties of metal-oxide-semiconductor structures. The shape and position of capacitance-voltage relationships in C vs V and 1/C to the 2nd power vs V coordinates is presented for eight structural and surface conditions, and qualitative (in some cases also quantitative) correlation of curve parameters to particular MOS models is indicated. Although actually measured CV curves are not expected to coincide fully with these idealized models, agreement in essential curve characteristics usually points to the predominance of that model in practical MOS structures. The report also contains a comprehensive literature reference on this subject. Author (TAB)

N67-36281*# Watkins-Johnson Co., Palo Alto, Calif.
DEVELOPMENT OF A 100 WATT S-BAND TRAVELING-WAVE TUBE Quarterly Report
L. A. Roberts and M. V. Purnell 12 Jun. 1967 27 p Prepared for JPL
(Contracts NAS7-100; JPL-951299)
(NASA-CR-88000; QR-3) CFSTI: HC $3.00/MF $0.65 CSCL 09A

Progress is reported in the development of a 100 W, 55% efficiency, 2.3 GHz traveling wave tube for space applications. Tubes S/N 4A, 4B, 4C, and 4D were built, and test results are given of tubes S/N 3, 4B, 4C, and 4D. Power output up to 140 W was reached. At the 100 W level, beam efficiency was 28%, and overall efficiency was greater than 35%. Beam focusing is excellent, including operation under depressed collector conditions. Saturation gain in excess of 30 dB at the 100 W, high-efficiency condition was achieved. Thermal and vibration tests were performed on one encapsulated tube. Results thus far indicate that the mechanical design is sound, free of resonances, and very low in values of spurious AM. A collector redesign is necessary to lower collector hotspot temperatures. The design concept of the improved collector has been worked out. K.W.

N67-36402*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
A RESETTABLE MONOSTABLE PULSE GENERATOR
Norman M. Garrahan Jul. 1967 11 p
(NASA-TM-X-55905; X-711-67-371) CFSTI: HC $3.00/MF $0.65 CSCL 09E

Galactic X-ray investigation requires the selection for measurement of individual X-ray particles from a multitude of other cosmic particles constantly impinging on the detecting sensors. To isolate a *lone* genuine X-ray event, a section of the logic requires a 10-microsecond blocking resettable memory to indicate a preceding absence of pulse pileup and to permit the sensors to reach their quiescent state. Such a circuit is discussed. A low-power solid-state *memory* circuit furnishes a blocking output state for a preset time duration upon receipt of a particle-pulse from the sensors. It is also capable upon receipt of an additional close-following particle-pulse (which could cause pulse pileup) of terminating the first preset time duration and commencing a new preset time duration without interruption to the existing blocking output state. Circuit operation is discussed in detail. Author

N67-36413# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
DEVICE FOR TRIGGERING DISCHARGE TUBES IN A HIGH-VOLTAGE PULSE GENERATOR [USTROYSTVO DLYA ZAPUSKA RAZRYADNIKOV V VYSOKOUOL'TNOM IMPUL'SNOM GENERATORE]
Yu. P. Usou 24 Feb. 1967 7 p Transl. into ENGLISH from Russian Patent No. 175085 (Appl. No. 883867/26-9, 24 Feb. 1964) 2 p
(FTD-HT-66-723; AD-655036)

The patent describes a device for triggering discharge tubes in a high-voltage pulse generator containing a generator of triggering pulses, electrodes of an ignition discharge tube, and a section of coaxial cable. For the purpose of preventing the shunting of the resistance of the load of the generator by the ignition circuit and the protection of the generator of the triggering generator from the action of high tension, a section of the coaxial cable over which the triggering pulse is passed to the ignition discharge tube is wound on a core of ferromagnetic material, and the sheath of the cable is grounded from the side of generator of the triggering pulses. TAB

N67-36481# Battelle-Northwest, Richland, Wash.
RADIATION INDUCED CHARGE MIGRATION IN MOS-FET TRANSISTORS
L. D. Philipp and P. O. Lauritzen (Washington Univ., Seattle) 10 Feb. 1967 11 p refs
(Contract AT(45-1)-1830)
(BNWL-SA-1101S; CONF-670708-1) CFSTI: HC $3.00/MF $0.65

The response of insulated-gate field-effect transistors (MOS-FET) to ^{60}Co irradiation was studied as the devices were operating in a common source mode. NSA

N67-36534# California Univ., Berkeley. Lawrence Radiation Lab.
COPPER-TAPE-WOUND, EDGE-COOLED SOLENOID
Donald W. Morris, Jack T. Tanabe, and Emery Zajec 30 Jan. 1967 10 p Presented at the Particle Accelerator Conf., Washington, D. C., 1–3 Mar. 1967
(Contract W-7405-ENG-48)
(UCRL-17262; CONF-670307-51) CFSTI: HC $3.00/MF $0.65

Construction details and tests of a 10-cm ID and 26.35-cm-long copper-tape-wound solenoid are described. Magnet measurements at 35 kW indicate an axial-field line integral of 193 kG-cm and a transverse-field line integral, measured on the geometric axis, of less than 0.1% of the axial-field integral. Author (NSA)

N67-36554*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
FLAT CONDUCTOR CABLE MANUFACTURE AND INSTALLATION TECHNIQUES
Wilhelm Angele Mar. 1967 28 p refs
(NASA-TM-X-53586) CFSTI: HC $3.00/MF $0.65 CSCL 09A

Flat conductor cables of various types are discussed. Emphasis is given to cable termination techniques, interconnection hardware, cable harness manufacture, and installation methods. Also presented are the results of an extensive flat cable installation exercise in the Saturn S-IVB stage. Author

N67-36616 Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf. Elektronik-Inst.
THE INFLUENCE OF DIFFERENT PULSE-FORMERS ON THE EFFICIENCY OF ANTICOINCIDENCE GATES
Peter Polly [1966] 16 p refs
(SGAE-E-7/1967)

Efficiency of an ideal pulse former is compared with that of a monostable vibrator, a Schmitt trigger, a multiple duration monostable vibrator, and a pulse former with a deadtime of the 2.-type. The realization of the pulse former with the 2.-type deadtime is discussed in principle, and specifications for such a design are included. This pulse former completely eliminates the additive terms in the anticoincidence gate that normally occur at high counting rates. M.W.R.

10 ELECTRONICS

Includes circuit theory; and feedback and control theory. For applications see: 09 Electronic Equipment. For related information see: Specific Physics Categories.

N67-36406# University of Southern Calif., Los Angeles. Electrical Engineering Dept.
ANALYSIS AND SYNTHESIS OF DISCRETE-TIME SYSTEMS WITH CONTROL SIGNALS OF VARIABLE AMPLITUDE AND PULSE-WIDTH
Louis R. Nardizzi Jun. 1967 126 p refs
(Grants AF-AFOSR-1018-66; AF-AFOSR-1018-67)
(USCEE-205; AFOSR-67-1487; AD-654632)

The problem considered consists of a general class of open-loop control systems which are driven by modulators whose output signals have either variable amplitude, pulse-width or combinations thereof. The admissible control set consists of r-dimensional control vectors, each component of which is bounded in amplitude and allowed at most one discontinuity (switching) within a sampling interval. The state vector representing the system to be controlled is n dimensional and the right-hand sides of the first order differential equations describing the system are continuous and have continuous first derivatives with respect to the states and the control inputs. The performance criterion to be minimized consists of a function of the states at the sampling instants and also a function of the states between the sampling instants. For the stated problem, general necessary conditions for an optimal sequence of amplitudes and pulse-widths are derived. These necessary conditions will apply to strict pulse-amplitude or pulse width modulation by simply deleting various parts of the general conditions. The computational and engineering aspects of the necessary conditions are dealt with in order to compare various forms of modulation. A number of examples illustrate the diverse nature of the open-loop solutions for different types of modulation. Based upon these open-loop solutions, a method is proposed which generates an approximate solution to the closed-loop problem. Author (TAB)

N67-35551# Utah Univ., Salt Lake City. Microwave Device and Physical Electronics Lab.
STUDY OF TRANSVERSE WAVE INTERACTIONS Second Triannual Report, Sep. 1–Dec. 31, 1966
R. L. Schriever, C. C. Johnson, and R. W. Grow Jul. 1967 63 p refs
(Contract DA-28-043-AMC-01279(E))
(UTEC-MD-67-015; ECOM-01279-6; Rept.-6; AD-655002)

The purpose of this project is to evaluate analytically and experimentally the interaction between a rotating electron beam and wave guide fields. The methods of analysis include use of a general coupled-mode theory, a ballistic computer program, and an experimental evaluation. An analysis of possible beam-flow patterns has been carried out by choosing some parameters and then numerically solving the equations for the resulting beam-flow characteristics. The interaction effect of multiple beams in the circuit has been considered by extending the coupled-mode theory to the multiple-beam case. The results of electron velocity spread have been investigated experimentally by modification of the device which results in a beam with higher velocity spread. The beam-flow analysis gives the properties of a proposed type of beam for use in a rotating beam interation. The multiple-beam interaction analysis indicates that the effect of multiple beams is a reduction in interaction strength which corresponds to the spatial variation of the wave guide fields. Axial velocity spread is found to seriously reduce the interaction strength. The beam-flow analysis and multiple-beam interaction suggest that the best approach to beam launching is to optimize the rotation of individual electrons rather than try to use a beam of the ideal form. Device interaction reveals that a beam-forming electrode in the gun will reduce the axial velocity spread and significantly improve the interaction strength. Author (TAB)

N67-35562# Purdue Univ., Lafayette, Ind. School of Electrical Engineering.
ANALYSIS AND SYNTHESIS OF MULTI-THRESHOLD LOGIC
K. S. Fu and W. C. W. Mow Jun. 1967 164 p refs
(Contract N00016-66-C-0076-A04; Grant NSF GK-696)
(TR-EE67-5; AD-654193)

The thesis treats a generalization of the concept of linearly-separable (single-threshold) Boolean functions, multi-threshold functions. Some invariance operations peculiar to the multi-threshold functions are shown to exist. Necessary and sufficient conditions of self-dual and self-complementary dual functions are obtained in terms of the multi-threshold weight threshold vector. In particular, self-dual and self-complementary dual functions are shown to be realizable by odd and even number of effective thresholds only. It is shown that an $n + 1$ variable self-dual and self-complementary dual can be generated from an n variable Boolean function. Such generation of self-dual and self-complementary dual functions are shown to correspond to the functional forms of self-dualization and self-complementary dualization of an n-variable Boolean function. An algorithm for the synthesis of multi-threshold threshold elements is presented. Instead of solving the set of linear inequalities, where the unknowns are the weights corresponding to the input variables, incremental weights are sought. The procedure reduces to that of resolving contradicting pairs of vertices by the incremental weights. The procedure is valid for linearly separable and non-linearly separable Boolean functions. For the synthesis of arbitrary Boolean functions with a network of single threshold elements, compound and cascade threshold element syntheses from the multi-threshold weight threshold vector are discussed. Finally, an improved tabulation of the multi-threshold weight threshold vectors on the 221 equivalence classes of four-variable Boolean functions under the NPN operation is included. Author (TAB)

N67-35801# Joint Publications Research Service, Washington, D. C.

TECHNICAL CYBERNETICS, NO. 3, 1967

21 Aug. 1967 351 p refs Transl. into ENGLISH of Tekhn. Kibernetika (Moscow), no. 3, 1967 p 1–208

(JPRS-42273: TT-67-32902) CFSTI: HC$3.00/MF$0.65

Articles on optimal control and distribution, system optimization, and various technical programming problems are presented. For individual titles see N67-35802–N67-35831.

N67-35802# Joint Publications Research Service, Washington, D. C.

A METHOD OF OPTIMAL CONTROL OF INDUSTRIAL PRODUCTION PROCESSES

G. N. Balasanov *In its* Tech. Cybernetics, No. 3, 1967 21 Aug. 1967 p 1–10 refs (See N67-35801 21-10)

A method is proposed for optimal control of industrial processes based on the use of linear set regression equations and the rules for selecting solutions in statistical games. This combination permits an increase in reliability of the decisions made when controlling an industrial process, and it permits correction of the conclusions reached on the basis of inexact regression equations by drawing on additional information about the process. Author

N67-35803# Joint Publications Research Service, Washington, D. C.

STATISTICAL MODEL OF AN INDUSTRIAL ENTERPRISE (IN THE EXAMPLE OF AN OIL REFINERY)

Kh. Sh. Margulis and G. Ya. Friedman *In its* Tech. Cybernetics, No. 3, 1967 21 Aug. 1967 p 11–21 refs (See N67-35801 21-10)

In the example of an oil refinery, the statistical (simulated) model of a complex system is constructed in which the production process and the control process are so closely related that a separate study of them is impossible. In the model, random disturbances affecting the system are taken into consideration. As the formalized system describing the system being studied, a self-adapting (extremal) automatic control system is assumed. A procedure is developed for simulation of the continuous action production process, and a principle for construction of the simulation algorithm which is more universal by comparison with the existing ones is proposed. The proposed model permits the solution of a number of problems in the sphere of design or prospective planning. Author

N67-35805# Joint Publications Research Service, Washington, D. C.

SEQUENTIAL OPTIMIZATION OF A DISCRETE CONTROL SYSTEM

V. M. Ponomarev and A. I. Ptushkin *In its* Tech. Cybernetics, No. 3, 1967 21 Aug. 1967 p 30–36 refs (See N67-35801 21-10)

The possibility of using the method of sequential optimization for synthesis of a linear discrete control law which is optimal with respect to accuracy is demonstrated. An example is presented which illustrates the rapid convergence of the series of solutions. Author

N67-35808# Joint Publications Research Service, Washington, D. C.

THE PROBLEM OF EXISTENCE OF SOLUTIONS OF OPTIMIZATION PROBLEMS WITH FIXED TIME

V. V. Podinovskiy *In its* Tech. Cybernetics, No. 3, 1967 21 Aug. 1967 p 62–69 refs (See N67-35801 21-10)

The existence theorem is proved for the problem of optimization of the process described by a system of differential equations with measurable right hand sides, that are linear with respect to controls. Author

N67-35809# Joint Publications Research Service, Washington, D. C.

THE APPLICATION OF THE METHOD OF DYNAMIC PROGRAMMING FOR THE SOLUTION OF A PROBLEM IN CHECKING HYPOTHESES

V. A. Petrov and G. V. Lavinskiy *In its* Tech., Cybernetics, No. 3, 1967 21 Aug. 1967 p 70–76 refs (See N67-35801 21-10)

The problem of selection of optimal dimensions of a rectangular decision-making region when selecting one out of two concurring hypotheses is investigated. Under certain assumptions in the distribution function, the procedure for the solution is based on the method of dynamic programming. The results of this work may find application in problems of identification when solving the problem of assignment of observations to a class characterized by a number of attributes. Author

N67-35810# Joint Publications Research Service, Washington, D. C.

VARIATION PROBLEM TRANSFORMATIONS, I

A. D. Ioffe *In its* Tech. Cybernetics, No. 3, 1967 21 Aug. 1967 p 77–91 refs (See N67-35801 21-10)

For correctly stated optimal control problems, proof is presented that the theorem of reduction to some conical form simplifies further investigation of the problem in many cases. Author

N67-35813# Joint Publications Research Service, Washington, D. C.

PROBLEMS IN SELECTING THE OPTIMAL MAINTENANCE CONDITIONS OF AN AUTOMATIC SYSTEM

A. M. Gorlin and A. Ye. Lobovskiy *In its* Tech. Cybernetics, No. 3, 1967 21 Aug. 1967 p 119–128 refs (See N67-35801 21-10)

An industrial automatic system is investigated, in which the optimal criterion of operation is the minimum operating cost. A method is proposed for determining the optimal preventive maintenance period of the system. Author

N67-35814# Joint Publications Research Service, Washington, D. C.

CONTROL OF ONE TYPE OF QUEUEING SYSTEM

N. M. Vorob'yev *In its* Tech. Cybernetics, No. 3, 1967 21 Aug. 1967 p 129–140 refs (See N67-35801 21-10)

The problem of control of the servicing time of a simplest flow of demands, where the profit of the system depends on the time of servicing a demand, is formulated as the control of an object with a simple structure and a random restriction on the number of possible controls. For this problem the Bellman equations are constructed, the necessary additional conditions are found and, for special cases, the procedures for solving the equations obtained are investigated. Author

N67-35815# Joint Publications Research Service, Washington, D. C.

TRANSFORMATION OF A STATIONARY POISSON FLOW INTO A NONSTATIONARY LINEARLY DEPENDENT FLOW

V. M. Boychenko and A. A. Nersesyants *In its* Tech. Cybernetics, No. 3, 1967 21 Aug. 1967 p 141–148 refs (See N67-35801 21-10)

The control system of stochastic discharge of a stationary Poisson flow of impulses to obtain a nonstationary Poisson flow with a density linearly dependent on an aribitrarily varying argument X is investigated. The degree of discharge is controlled directly from the binary elements of the counter X. Attention is focused on the development and investigation of a functional diagram of the device for conversion of the stationary Poisson flow of random impulses with the parameter Λ into a nonstationary flow with the parameter $\lambda = KX$ where λ is a linear function of X with an angular coefficient K. Author

N67-35818# Joint Publications Research Service, Washington, D. C.

SET THEORY AND ALGEBRAIC OPERATIONS ON FINITE AUTOMATA

A. N. Melikhov and Yu. A. Dvoryantsev *In its* Tech. Cybernetics, No. 3, 1967 21 Aug. 1967 p 176–190 refs (See N67-35801 21-10)

The assignment of finite automata with the help of graphs is investigated. Operations of combination, intersection, multiplication, and summation on automata are defined in the language of graph theory, and the basic relationships between the operations are presented. The interrelationship between subdivisions of free half-groups which correspond to initial and resultant automata is established. The operations of multiplication and summation on probability automata, which are a generalization of determinate finite automata, are introduced. Author

N67-35819# Joint Publications Research Service, Washington, D. C.

THE SYNTHESIS OF A TYPE OF MICROPROGRAM AUTOMATA

G. V. Kreynin, V. G. Lazarev, and Ye. I. Piyl' *In its* Tech. Cybernetics, No. 3, 1967 21 Aug. 1967 p 191–201 refs (See N67-35801 21-10)

A certain type of microprogram automata is considered during the synthesis of which, due to the properties of functional blocks, it is possible to use special microcommands called complex commands. An algorithm is presented for obtaining complex microcommands. It is shown that the application of such automata permits a reduction in volume of equipment in the control device. Author

N67-35820# Joint Publications Research Service, Washington, D. C.

THE SYNTHESIS OF AUTOMATA WITH MINIMUM FREQUENCY OF USE OF MEMORY ELEMENTS

Ye. N. Vovilov and L. P. Lobanov *In its* Tech. Cybernetics, No. 3, 1967 21 Aug. 1967 p 202–207 refs (See N67-35801 21-10)

Algorithms for the synthesis of automata insuring the least mean frequency of use of memory elements or the minimum power consumption are considered. Author

N67-35821# Joint Publications Research Service, Washington, D. C.

MULTIVALUED LOGICAL ELEMENTS WITH THE PULSE PHASE PRINCIPLE OF REPRESENTATION OF INFORMATION

V. I. Korneychuk, A. M. Romankevich, L. S. Sitnikov, and L. L. Utyakov *In its* Tech. Cybernetics, No. 3, 1967 21 Aug. 1967 p 208–214 refs (See N67-35801 21-10)

Systems of logical elements are proposed which operate on the pulse phase principle of representation of information, and which realize the operations of certain complete systems of k-valued switching functions. The complexity of the proposed systems does not depend on k. It is shown that the application of such elements permites broad use of known systems applied in binary techniques and equipment. Author

N67-35822# Joint Publications Research Service, Washington, D. C.

POLYNOMIAL REPRESENTATIONS OF BOOLEAN FUNCTIONS AND THEIR MINIMIZATION

Zh. Toshich *In its* Tech. Cybernetics, No. 3, 1967 21 Aug. 1967 p 215–219 refs (See N67-35801 21-10)

The expended Zhegalkin algebra containing product functions with respect to modulus two, sums with respect to two, and negation is investigated. Methods are proposed for minimization analogous to the methods of minimization in Boolean algebra. Author

N67-35826# Joint Publications Research Service, Washington, D. C.

A DISCRETE TERMINAL STATE CONTROL SYSTEM

V. I. Petrov *In its* Tech. Cybernetics, No. 3, 1967 21 Aug. 1967 p 255–264 refs (See N67-35801 21-10)

A method is proposed for construction of a closed terminal state control system consisting in the selection of a definite deviation program for the servomechanisms and its subsequent correction at a number of points. The possible error from disturbances is also estimated. The application of the method for the solution of the problem of aircraft guidance in the landing phase is considered. Author

N67-35829# Joint Publications Research Service, Washington, D. C.

A NEW TYPE OF DIRECTIONAL GRAPH AND ITS APPLICATION FOR THE ANALYSIS OF ELECTRIC CIRCUITS

A. M. Suchilin *In its* Tech. Cybernetics, No. 3, 1967 21 Aug. 1967 p 286–301 refs (See N67-35801 21-10)

A directional graph of equations, the vertices of which are their coefficients, is investigated. The formal method of transition from the line or equivalent diagram of an electrical circuit to the graph of the coefficients, and the topological algorithms for determination of the transfer functions of the passive and additive circuits with respect to their graphs are presented. The possibility of using the graph of the coefficients for construction of model diagrams is shown. Author

N67-35830# Joint Publications Research Service, Washington, D. C.

INDIRECT ACTION OPTIMAL STATIC INFORMATION SYSTEMS

V. Ya. Rotach and M. B. Khadzhiyski *In its* Tech. Cybernetics, No. 3, 1967 21 Aug. 1967 p 302–311 refs (See N67-35801 21-10)

The problem of determination of the optimal values of the coefficients of a computational device for an indirect action static information system is investigated, beginning with the condition of minimum error dispersions in the measurements. Author

N67-35862*# Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.

TIME DOMAIN ANALYSIS OF IMPULSIVE RESPONSE TRAINS

Thomas G. Kincaid (Ph.D. Thesis) 31 May 1967 71 p refs

(Grant NsG-496; Contract DA-36-039-AMC-03200(E)); Grants NIH MH-04737-05; NSF GP-2495)

(NASA-CR-88206; TR-445) CSCL 09C

This report shows how to find the kernel of an impulse response train directly from the signal itself. The method assumes that the spacing of the impulses is known, but requires no knowledge of their areas, and also that the impulse response train is of finite duration. Since the kernel of an impulse response train is rarely unique, the method cannot always find the impulse response of the system that actually generated the signal. Rather, the method finds the kernel of shortest duration. For impulse response trains of finite duration there is only one such kernel, and all other kernels are impulse response trains having it as their kernel. Therefore, for the purpose of simulating the system and characterizing the signal, the kernel of minimum duration is sufficient. The method used to find the kernel involves only matrix multiplication and the solving of simultaneous linear equations. Once the kernel is found, the impulse areas can be determined, again, by the solution of simultaneous linear equations. All of these operations can be routinely carried out by an electronic digital computer. Author

N67-35917*# Arizona Univ., Tucson. Dept. of Nuclear Engineering.
SENSITIVITY AND STATE-VARIABLE FEEDBACK
Robert C. White Jul. 1967 88 p refs
(Grant NGR-03-002-115)
(NASA-CR-88001) CFSTI: HC $3.00/MF $0.65 CSCL 09C

Two new time-domain sensitivity measures, integral sensitivity and peak sensitivity, are defined in terms of the sensitivity function. A relation between integral sensitivity and classical frequency-domain sensitivity is established, and the generation of classical sensitivities, sensitivity functions, peak sensitivity, and integral sensitivity is discussed. Classical sensitivity is employed in a comparison of the sensitivity properties of linear control systems designed by two methods: series compensation and state-variable feedback. It is shown that under certain conditions the system designed by feeding back all of the state variables may be expected to be less sensitive than the series compensated system. A modification of state-variable feedback, the H-equivalent system, is considered in a further attempt to reduce sensitivity to parameter changes. Author

N67-35936# Tokyo Univ. (Japan). Inst. of Space and Aeronautical Science.
HIGH-ACCURACY SPEED CONTROLLER USING PULSE COUNTING METHODS
Yasushi Ishii Jun. 1967 14 p refs
(ISAS-414, Vol. 32, No. 7) CFSTI: HC $3.00/MF $0.65

A digital controller for accurate speed control of electric motors is reported. The speed is measured by counting the number of pulses from the pickup for a precisely determined period. The comparison of the measured speed with the reference is performed by a preset counter through a relatively simple method. An analog integrator is used to convert the digital error signal into a voltage signal. This voltage is fed into a power amplifier and controls the motor. The main part of this controller is multiplexed by time-division so that it can control two motors at a time. A new pulse frequency multiplier, which is useful for the digital speed control, is also developed. The principles and circuits of those devices as well as some test results are described. Author

N67-35943# Information Research Associates, Inc., Lexington, Mass.
PATTERN RECOGNITION OF STOCHASTIC PROCESSES
Donald B. Brick and Joel Owen 23 Jun. 1967 42 p refs Revised
(Contracts Nonr-4752(00); AF 49(638)-1631; AF 33(615)-3758)
(TR-9; AD-654199)

Representations for the likelihood functions of separable stochastic processes in terms of a denumerable set of functionals of the processes are developed. The objective in utilizing these representations is as an aid in signal detection, classification (waveform recognition), parameter extraction, etc. The approach to these operations is from the point of view of maximum likelihood (Bayes risk). Knowledge of the distributional properties of the functionals is sufficient to derive those of the process. It is shown that when the process has orthogonal bounded increments, the functionals are multivariate normal; the means and covariance matrix being readily calculable. Additionally, if the process has stationary (wide-sense) increments, the functionals are statistically independent. It is further shown that (a) the orthogonal-increment process can be described by a normal distribution and (b) if its increments are stationary (wide-sense), the process is distributed and behaves as a Wiener process. Examples of the application of these results to stochastic-process signal detection and waveform pattern recognition are given. Explicit expressions for the coefficients of the Wiener canonical expansion for the likelihood function of such a process are derived. Author (TAB)

N67-35957*# Massachusetts Inst. of Tech., Cambridge. Engineering Projects Lab.
SIMULATION AND ANALYSIS OF OPTIMAL SELF-PACED SECOND ORDER CONTROL SYSTEMS
Philip A. Hardin Jul. 1967 29 p refs
(Grant NsG-107-61)
(NASA-CR-88201; DSR-70283-2) CFSTI: HC $3.00/MF $0.65 CSCL 09C

A local variation of Bellman's dynamic programming and the simulation of a second-order self-paced control system are presented. The major advantage of the local variation of the dynamic programming algorithm is that the grid upon which a continuous system is simulated can be made several orders of magnitude smaller than when using the dynamic programming to simulate the same system. A second-order, optimal, self-paced control system was simulated using the IBM 7094 computer. The methods of simulation were: (1) Bellman's dynamic programming, (2) a modification that uses the algorithm to consider points around a nominal, non-optimal trajectory instead of all points in the state space, and (3) a classical gradient analysis. The first method produced satisfactory results, although the grid on which the self-paced system was simulated was very coarse. The second method increased the grid resolution and produced better (lower cost) trajectories, but had one weakness in that it could become trapped in local minima. The gradient method was found to be effective in analyzing only certain types of self-paced system. Author

N67-35998# National Research Council of Canada, Ottawa (Ontario). Control Systems Lab.
THE DESIGN OF OPTIMAL EXTREMAL CONTROLLERS
C. M. Woodside *In its* Div. of Mech. Eng. and the Natl. Aero. Estab. 31 Mar. 1967 p 1-53 refs (See N67-35995 21-34)

Summary technical data is presented on the design of optimal extremal controllers that are used to attempt to minimize a cost index for a plant or process by trial and error manipulation of one or more independent variables. Five elementary extremal controllers are intensively studied and empirical formulas for optimal generation, in the sense of least mean squared error, are developed. An extension is made of a preliminary approximate design for one type of stepwise controller. The approach is largely empirical, combining dimensional analysis, intuitive considerations, and experimental results to give dimensionless design curves. Together with graphics, equations, and bibliography, the relevant conclusions are analyzed. R.U.

N67-36026# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
AUTOMATIC CORRELATERS AND THEIR APPLICATION
B. S. Sinitsyn 19 Apr. 1967 193 p refs Transl. into ENGLISH of the book "Avtomaticheskiye Korrelyatory i Ikh Primeneniye" Novosibirsk Redaktsionne-izd. Otd. Sibir. Otd. AN SSSR, 1964 p 1-218
(FTD-MT-65-179; TT-67-62277; AD-655018)

Contemporary automated measuring devices frequently deserve the name of systems. This book is devoted to consideration of one of the important varieties of these systems—automatic correlators. They are applied, certainly in various technical form, in all areas. Data on correlators and their application are encountered in many books and journal articles, but we know of only one monograph (F. H. Lange, 1959- wholly devoted to correlation equipment and its different applications, mainly in communications engineering. The book assembles available data on correlators and to consider the latter to be measuring systems; i.e., to emphasize possibility of their application not only for transmission and reception of already separated information, but also their suitability as means of searching for this information during the study of phenomena of nature and engineering processes. It is necessary to stipulate that while correlation methods in communications engineering and

in automatic adjustment and control are applied more widely than in measuring technology, there is not excluded, however, the possibility that this relationship will change in favor of the latter. Author (TAB)

N67-36107* Scientific Translation Service, La Canada, Calif.
CALCULATION OF A GUN FOR SHAPING A HELICAL ELECTRON BEAM OF HIGH TRANSVERSE ELECTRON ENERGY [O RASCHETE PUSHKI DLYA FORMIROVANIYA VINTOVOGO ELEKTRONNOGO PUCHKA S BOL'SHOY POPERECHNOY ENERGIYEY ELEKTRONOV]
S. D. Luchinin and I. N. Nazarov Washington, NASA, Jul. 1967 11 p refs Transl. into ENGLISH from Izv. Sibirsk. Otd. Akad. Nauk. SSSR, Ser. Tekhn. Nauk (Novosibirsk), no. 6, issue 2, 1966 p 17–24
(Contract NASw-1496)
(NASA-TT-F-11145) CSCL 09C

An electron gun for producing helical electron beams with a prescribed high transverse/longitudinal electron energy ratio is discussed. The motion of a non-paraxial electron in the field of a short magnetic lens is analyzed. The selection of initial conditions for the formation of a helical electron beam is made. An electron gun design of this type is described. Author

N67-36169# RAND Corp., Santa Monica, Calif.
GENERALIZED FUNCTIONS AND A DELAY-INTEGRATOR WITH NEGATIVE FEEDBACK
Allen Klinger Jun. 1967 19 p refs
(Contract F44620-67-C-0045; Proj. RAND)
(RM-4672-PR; AD-654280)

An analysis, using the techniques of system theory, of a difference-differential equation in an application involving generalized functions. The tools of Laplace transforms, block diagrams, and timing diagrams are used to obtain the Green's function or impulse response, and the response to impulses of higher order. The physical unit that gives rise to difference-differential equations is the delay-integrator with negative feedback. It is connected by an electrical transmission line to a direct coupled (operational, analog computer) amplifier. The critical value of the delay parameter is determined, and stable and unstable responses are exhibited at different parameters. The main result is that the impulse response of the system with time-lag is the Green's function only if the dynamics are expressed in terms of the output; without delay, the impulse response is the Green's function of the state equations themselves.
Author (TAB)

N67-36192 Joint Publications Research Service, Washington, D. C.
AUTOMATIC MACHINES WITH VARIABLE STRUCTURE
G. A. Agasandyan 10 Aug. 1967 6 p ref Transl. into ENGLISH from Dokl. Akad. Nauk SSSR (Moscow), v. 174, no. 3, 1967 p 529–530
(JPRS-42178; TT-67-32808) CFSTI: HC $3.00

Problems of neurophysiology led to the mathematical theory of automatic machines. One limitation of this theory is the condition of invariability with time of the transient function of the automatic machine. It has been found that only events constructively fixed by regular expressions can be represented. Many problems involve automatic structures in which the transient functions are variable. The study of the expanded possibilities of the automaton in this case is the content of this article. The method used is that of D. Michael. Author

N67-36492# Harry Diamonds Labs., Washington, D. C.
A TECHNIQUE FOR MEASURING PULSE-TRAIN JITTER
A. Singer, I. S. Friedberg, and E. Naess Apr. 1967 25 p ref
(HDL-TM-67-4; AD-654348)

A quantitative definition of pulse-train jitter, for measurement purposes, is developed. It consists essentially of showing that pulse jitter reflects as a modulation of each harmonic of the 'mean' pulse train, and that consequently the jitter may be expressed as the ratio of the jitter power in the am sidebands, associated with a convenient harmonic to the power in that harmonic. A detailed description of the instrumentation necessary for quantitative jitter measurements is given; examples of measurements on 7C-GHz magnetrons (BL-234C) are cited. The uniqueness of this technique lies in the relative ease with which it can be instrumented. Author (TAB)

11 FACILITIES, RESEARCH AND SUPPORT

Includes airports; lunar and planetary bases including associated vehicles; ground support systems; related logistics; simulators; test facilities (e.g., rocket engine test stands, shock tubes, and wind tunnels); test ranges; and tracking stations.

N67-35408# Toronto Univ. (Ontario). Inst. for Aerospace Studies.
THE APPLICATION OF IMPLOSION WAVE DYNAMICS TO A HYPERVELOCITY LAUNCHER
Robert F. Flagg Jun. 1967 269 p refs
(Contract AF 33(615)-2766)
(UTIAS-125; AD-654273)

A detailed theoretical and experimental study of the concept of using spherical implosions as the driving mechanism for producing projectiles with velocities of the order of 50,000 feet per second was made. Experimental results which include launchings of 0.22 and 0.312 inch diameter, one caliber, magnesium and polyethelene projectiles, up to velocities of 17,000 feet per second verify the validity of the implosion driving concept. The performance limit is dictated by apparatus limitations and is not representative of the ultimate performance limit for implosion drivers. Calculations are included which indicate the feasibility of accelerating 1 inch diameter projectiles, 1 caliber long (rho = 1.0 g/cc) to 50,000 feet per second in a larger launcher having a 30 inch diameter hemispherical chamber and a 1.0 inch liner of explosive. The results of a study undertaken to determine the explosive materials and conditions that can be used for generating the implosion are presented and show that several explosive materials, including several PETN formulations, lead azide, nitrocellulose and combinations of these have properties that make them amenable to initiation by an impinging gaseous detonation wave. It was proven conclusively that symmetric spherical implosions can be produced by using gaseous detonation waves at moderate pressures to initiate safe, secondary, solid explosives. Author (TAB)

N67-35441# Oak Ridge National Lab., Tenn.
MAGNET SYSTEM FOR A 4-MeV EXPERIMENTAL SEPARATED ORBIT CYCLOTRON
E. D. Hudson and F. E. McDaniel [1967] 4 p refs Presented at the Natl. Particle Accelerator Conf., Washington, D. C., 1–3 Mar. 1967 Submitted for publication
(Contract W-7405-ENG-26)
(ORNL-P-3092; CONF-670307-55) CFSTI: HC $3.00/MF $0.65

One of six sector-magnets for the 4-MeV Separated Orbit Cyclotron Experiment (SOCE) was assembled and tested. The magnets for the SOCE are quite different and much simplified from previous SOC magnet concepts; all pole tips are of the same radius of curvature and each set is excited by a separate coil-pair. The pole-tip fields vary smoothly from 3.5 kilogauss at injection (1 MeV) to 6.6 kilogauss at full energy. The field index, n, varies

from 0.58 to 0.52. A unique pole-tip design with an integral vacuum chamber has been developed. The ampere-turn requirements for the main pole-tip coils and trimming coils have been determined. A simple but highly precise magnetic field scanning device was developed for use with the SOCE magnets. Author (NSA)

N67-35450# California Univ., Livermore. Lawrence Radiation Lab.

A LIGHTWEIGHT, 1-METER-DIAMETER, 12 KG SUPERCONDUCTING MAGNET SYSTEM FOR A BALLOON-CARRIED COSMIC RAY EXPERIMENT

Clyde E. Taylor 28 Apr. 1967 14 p refs Presented at the 2d Intern. Conf. on Magnet Technol., Oxford, 11–14 Jul. 1967
(Contract W-7405-ENG-48)
(UCRL-70285; CONF-670705-1) CFSTI: HC $3.00/MF $0.65

For cosmic-ray studies at high altitudes a very lightweight magnet system is required, with large aperture and with magnetic field normal to the particle path. Such a coil is being built at the Lawrence Radiation Laboratory, University of California, Livermore, for a balloon-carried experiment proposed by Professor Luis Alvarez. The complete coil and Dewar system will be tested in July 1967. The main features of this coil system including field configuration, structural problems, and construction details are discussed. Author (NSA)

N67-35478# Toronto Univ. (Ontario). Inst. for Aerospace Studies.

IMPLOSION DRIVEN HYPERVELOCITY LAUNCHER PERFORMANCE USING GASEOUS DETONATION WAVES

J. D. Watson May 1967 84 p refs
(Contract AF 33(615)-2766)
(UTIAS-TN-113; AD-654276)

An experimental investigation of the performance of the UTIAS Implosion-Driven Hypervelocity Launcher was made in preparation for the investigation of launcher performance using explosive liners. Initial gaseous mixtures of stoichiometric hydrogen and oxygen diluted with hydrogen or helium in the initial pressure range from 100 psi to 500 psi were used. The detonation velocities and the subsequent trajectories of the reflected shock waves in the hemispherical combustion chamber were determined for the various initial mixtures. The measured detonation velocities in this high-pressure range agree very well with theory. Gun performance for the various reservoir conditions was investigated and the performance utilizing imploding shock waves is compared to the performance using deflagrating or constant volume combustion. Author (TAB)

N67-35604# Ballistic Research Labs., Aberdeen Proving Ground, Md.

MULTIPLE POINT IGNITION IN HARP GUNS

C. H. Murphy, G. V. Bull, and D. Lyster (McGill Univ.) Mar. 1967 34 p refs
(BRL-MR-1832; AD-654370)

The usual powder charge in the 16-inch HARP gun can be as long as 12 feet in an even longer chamber. If the charge length is more than 2 feet shorter than the available chamber, the pressure time curve can be significantly improved by dividing this interval into 2 to 4 sub-intervals by use of wooden spacers. An even more dramatic improvement can be achieved by igniting this column of powder at several points. Recently, five point ignition with two squibs in each location was used in the 119-foot long 16-inch gun with very good results. The service charge for a 16-inch gun is 660 pounds of standard 16-inch gun propellant. This charge will launch a 3000-pound projectile at 2800 feet per second, but is too slow burning to launch the standard HARP projectile plus sabot weight of 410 pounds at this velocity. With multiple point ignition, 1275 pounds of this old propellant accelerated the HARP projectile to 5900 feet per second, and an apogee of 414,000 feet was achieved. Even better performance can be achieved with multiple point ignition. A WM/M propellant with 0.220 web, 920 pounds, allows the HARP projectile to reach 6800 feet per second and an altitude of 540,000 feet while a 0.225 M8M propellant yields a muzzle velocity of 7000 feet per second and 590,000 feet apogee. Author (TAB)

N67-35639# Air Force Missile Development Center, Holloman AFB, N. Mex.

EVALUATION OF AN EXTENDIBLE AERODYNAMIC DRAG BRAKE FOR MONORAIL ROCKET SLEDS

Daniel J. Krupovage May 1967 28 p refs
(MDC-TR-67-69; AD-654271)

Velocity versus coast distance measurements on one monorail rocket sled were conducted to obtain quantitative information on the braking effectiveness of an extendible aerodynamic drag brake. The data were obtained by means of ribbon frame cameras and reduced to the form of drag coefficients for the rocket sled and aerodynamic drag brake. The drag brake as described has a drag coefficient of approximately 1.68 in the subsonic regime and approximately 1.8 in the supersonic regime. Author (TAB)

N67-35662*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

MODIFICATION OF THE GODDARD OPTICAL RESEARCH FACILITY Preliminary Engineering Report

Aug. 1967 29 p
(NASA-TM-X-55888; X-271-67-405) CSCL 14B

Building modifications to an optical research facility, which tracks and determines position of satellites with lasers, are cited. Construction of a field elevated laboratory for a program to determine the effects of atmospheric turbulence on coherent laser communication is discussed. Factors such as site selection, architecture, structure, plumbing, heating ventilation and air conditioning, and electrical systems are considered. Also included are a construction schedule, cost estimates, and drawings. S.P.

N67-35732*# National Aeronautics and Space Administration. Langley Research Langley Station, Va.

DETERMINATION OF BOUNDARY-REFLECTED-DISTURBANCE LENGTHS IN THE LANGLEY 16-FOOT TRANSONIC TUNNEL

Francis J. Capone and Edward M. Coates, Jr. Washington, NASA, Sep. 1967 70 p refs
(NASA-TN-D-4153) CFSTI: HC $3.00/MF $0.65 CSCL 14B

An investigation has been conducted to determine boundary-reflected-disturbance lengths in the Langley 16-foot transonic tunnel. Cone-cylinder and ogive-cylinder bodies were tested at Mach numbers from 0.70 to 1.30 and at angles of attack from $-3.8°$ to $4.0°$. Geometric variables included nose-cone half-angle, body diameter, and body length. The test Reynolds number per meter varied from 10.66×10^6 to 13.25×10^6 (test Reynolds number per foot varied from 3.25×10^6 to 4.04×10^6. Results showed that the stronger the bow shock wave, the shorter the maximum interference-free model length as a result of the boundary-reflected disturbance. Some wind-tunnel-wall interference associated with the reflected expansion field emanating at the cone-cylinder juncture was experienced for the bodies with 0.1980-percent blockage at Mach number of 1.00. No interference was found for a 0.0062-percent-blockage body. Base pressure was influenced by the proximity of the boundary-reflected disturbance at the base of the model. Author

N67-35835# Brookhaven National Lab., Upton, N. Y.

PENNING DISCHARGE ION SOURCE FOR HIGH BRIGHTNESS

G. W. Bennett and C. M. Turner [1966] 12 p refs Presented at the Natl. Particle Accelerator Conf., Washington, D. C. Prepared for AEC
(BNL-11364; CONF-670307-46) CFSTI: HC $3.00/MF $0.65

The development, characteristics and emittance of the Penning discharge ion source used in the Cosmotron injector are described. The maximum value of brightness reported is 3×10^{12} mA cm^{-2} rad^{-2} at 78 mA total current, 23 keV beam energy. The results are superior to recent values for duoplasmatrons from various laboratories, except for total current. Author (NSA)

N67-35837# Brookhaven National Lab., Upton, N. Y.
IMPROVEMENT OF HYDROGEN PUMPING CHARACTERISTICS OF PENNING DISCHARGE GETTER-ION PUMPS
C. M. Turner, J. G. Marinuzzi, and G. W. Bennett [1967] 5 p refs Presented at the Natl. Particle Accelerator Conf., Washington, D. C.
(BNL-11365; CONF-670307-48) CFSTI: HC $3.00/MF $0.65

Pumping hydrogen with Penning discharge getter-ion pumps at the flow rates normally encountered with accelerators employing hydrogen ion sources presents problems that do not appear when these pumps are employed on systems where the only gas load is that arising from surface degassing and residual leakage. These problems are thermal instability resulting from reemission of absorbed hydrogen, and deformation of the titanium cathodes with hydrogen absorption. This report outlines the pertinent considerations involved in modification of the design of the pumping elements of a standard 500 l/s pump (air rating), to increase by a factor of about 10 to hydrogen gas load the pump can handle without danger of thermal instability, and to virtually eliminate titanium deformation. Hydrogen gas loads of up to 50 atm cm^3/min can now be accommodated with a 500 l/s pump. While service life expectancy was previously limited to 2000–3000 hours by anode–cathode short circuit, it is presently limited by the ultimate hydrogen absorption capacity of the titanium. Author (NSA)

N67-35905# Los Alamos Scientific Lab., N. Mex.
CRYOGENIC RESEARCH AT THE LOS ALAMOS SCIENTIFIC LABORATORY
E. F. Hammel [1967] 31 p refs Presented at the Intern. Cryog. Eng. Conf., Kyoto
(Contract W-7405-ENG-36)
(LA-DC-8725; CONF-670409-2) CFSTI: HC $3.00/MF $0.65

Facilities used in cryogenic research at the Los Alamos Scientific Laboratory for the development of high thrust nuclear propulsion systems for space exploration are discussed. The largest cryogenic test cell is described and cryogenic engineering items such as storage dewars, axial flow pumps capable of attaining 100 atm pressure, H_2O–H_2 heat exchangers, vacuum jacketed transfer lines and flow control systems are discussed. Problems of superconductivity and superfluidity are analyzed. Self-pressurization studies, providing insight into the heat energy distribution in storage dewars are described. NSA

N67-35958 College of Aeronautics, Cranfield (England). Dept. of Aerodynamics.
THE COLLEGE OF AERONAUTICS WHIRLING ARM, INITIAL DEVELOPMENT TESTS
P. E. Kumar May 1967 14 p refs
(COA-AERO-174)

A whirling arm facility for the study of ground effect on wings, and other craft operating near the ground is described. The model is mounted on struts, and moves over an adjustable floor in specially constructed channel. The initial tests conducted on the arm towards making it a fully operational facility are discussed. It is concluded that a full yaw-meter survey is necessary to define the air-flow existing in the channel, during operation of the arm, and that the instrumentation being used needs to be further developed. Author

N67-35971*# TRW Systems, Redondo Beach, Calif.
THEORETICAL AND EXPERIMENTAL STUDIES RELATING TO USE OF A LINEAR ACCELERATOR FOR MICROMETEOROIDS Final Report
J. C. Slattery and D. G. Becker Apr. 1967 141 p refs
(Contract NAS1-4099)
(NASA-CR-66466; TRW-03716-6010-R000) CSCL 20G

A linear accelerator for accelerating micron-size particles to meteoroid velocities is described. The accelerator employs a Widerac–Sloan–Lawrence configuration. It is operated in a radially-stable mode and the frequency of the accelerating voltage is automatically adjusted to accept charged micron-size spheres with charge to mass ratio of 1–300 coul/kg. The waveform applied is a "drooping square wave" which allows focusing adjustments to be made independent of frequency and phase. The change in phase over 93 gaps can be kept sufficiently small by proper selection of droop and other parameters so that acceleration occurs at all gaps. Injection is at 1.6 MV from a modified Van de Graaff accelerator. The linac adds an additional 9.3 MV. Velocities in excess of 30 km/s have been reached. Author

N67-36000# California Univ., Berkeley. The Inst. of Transportation and Traffic Engineering.
EVALUATION OF CENTERLINE-LIGHTING INDICATIONS FOR RUNWAY-DISTANCE REMAINING AND TAXIWAY EXITS Final Report
D. M. Finch, R. Horonjeff, and K. Mellander Jun. 1967 36 p refs
(Contract FAA-ARDS-434)
(SRDS-RD-67-10) CFSTI: HC $3.00/MF $0.65

Tests were conducted to determine the effectiveness of colored centerline lights for indicating runway-distance remaining and for marking high-speed taxiway exits (large-radius turn-offs) under daytime and nighttime visibility conditions down to 700 ft of visual range. The tests consisted of observations by pilots of various lighting patterns under simulated rollout conditions. The results indicate that red centerline lights can be effectively used either in combination with white lights or alone if the intensity of the red lights is high enough to provide adequate guidance under reduced visibility. Results also indicate that under conditions of 700 ft visual range, adequate identification and guidance for large-radius taxiway turnoffs can be provided by steady-burning, green lights along the taxiway centerlines, with a pattern having an equivalent intensity at least that of 1000 cp lights at 12.5 ft spacing in daytime and 500 cp at 12.5 ft at night. Steady-burning taxiway lights were preferred by the pilots over flashing lights. Taxiway centerline lights having a much wider beam than that specified by the FAA were visible from a point on the runway centerline farther beyond the beginning of the taxiway turnoff than were the specified narrower-beam lights. Author

N67-36038# College of Aeronautics, Cranfield (England).
THE DEVELOPMENT AT CRANFIELD OF A FREE PISTON COMPRESSION SHOCK TUBE
M. J. Pratt Feb. 1967 20 p refs
(COA-AERO-194)

The free piston compression shock tube provides a simple means of obtaining shock Mach numbers of the order of 30. This report concerns the design and development of such a shock tube. The problems encountered in evolving a piston capable of withstanding heavy impacts at the completion of its strokes are outlined, and some preliminary shock tube performance data given. Author

N67-36050# Oak Ridge National Lab., Tenn.
A SECTOR MAGNET FOR A 10–50 MeV SOC
E. D. Hudson, S. R. Lord, and F. E. McDaniel 1966 4 p refs Presented at the Natl. Particle Accelerator Conf., Washington, D. C.
(Contract W-7405-ENG-26)
(ORNL-P-3091; CONF-670307-56) CFSTI: HC $3.00/MF $0.65

A full-scale prototype magnet sector of a 12-sector, 10–50 MeV separated orbit cyclotron was built and tested. Eleven pairs of alternating-gradient pole tips are mounted on a yoke structure which provides a common magnetic return path. The pole tips are all excited by a single pair of coils which surround the pole tip mounting bases at the upper and lower yoke faces. The pole tips combine both the negative- and positive-gradient sections in a single unit; the magnetic field gradients are about 800 gauss/in. The pole tips are 4.5 in. wide and have a mean gap of 1.75 in. They were machined by the numeric controlled milling process. Special edge contours were developed to achieve a useful radial aperture of 3 inches. Experience with the prototype magnet demonstrates that magnets for separated orbit cyclotrons present no special difficulty in design, construction, or alignment. Author (NSA)

N67-36073# Stanford Univ., Calif. High Energy Physics Lab.
DESIGN OF A HIGH ENERGY, HIGH DUTY CYCLE RACETRACK MICROTRON
B. H. Wiik and P. B. Wilson May 1967 36 p refs Submitted for publication
(Contract Nonr-225(67))
(HEPL-493; AD-654893)

The calculated properties of the split-magnet racetrack microtron compare very favorably with the properties of other types of electron accelerators in the 100-600 MeV energy range. In comparison with an electron linac using a comparable amount of average rf power, the energy homogeneity and duty cycle of the microtron are superior by an order of magnitude, while the average current is comparable. In addition, the microtron is considerably more compact. Compared with other circular accelerators, the microtron has the advantage of high average current and the ease of beam extraction associated with a linac. A rough estimate was made of the cost of the major components for the proposed microtron. Included in the estimate is the cost of magnets, quadrupoles, klystrons, modulators, rf components, accelerating structures, vacuum chamber, injector, and an allowance for miscellaneous items. The cost of these components for the 400 MeV machine, using the lower power 3% duty cycle rf system, is estimated to be less than 1-1/2 million dollars. For the 600 MeV microtron, using the higher duty cycle rf system, the cost of the bare machine is estimated to be about two million dollars. The cost of housing, installation, and experimental facilities must be added to the preceding figures. It is estimated that the cost for a completed machine of the design proposed here would be about 20 to 30% of the cost for an electron linac with comparable energy and duty cycle. Author (TAB)

N67-36075# Brookhaven National Lab., Upton, N. Y. Accelerator Dept.
STUDY OF A LARGE APERTURE AG SYNCHROTRON MAGNET
P. F. Dahl and G. Parzen 15 May 1967 11 p refs
(BNL-11441; AADD-137) CFSTI: HC$3.00/MF$0.65

A study was made of an AG synchrotron magnet with a 12 inch good field aperture and a 7 inch magnet gap. This magnet was considered as part of a design study of a possible booster AGS for the Brookhaven AG synchrotron. NSA

N67-36127# Nationaal Lucht-en Ruimtevaartlaboratorium, Amsterdam (Netherlands). National Aerospace Lab.
NUMERICAL METHODS FOR THE DESIGN OF VARIABLE MACH NUMBER LAVAL NOZZLES
G. Y. Nieuwland *In its* Rept. and Trans., Vol. 32 1967 19 p refs (See N67-36124 21-14)
(NLR-TR-T.124)

Applications are presented for a number of computational methods connected with the design of a variable Laval nozzle. First, Laval nozzle flows are defined as a Cauchy problem with the axial velocity distribution as initial conditions. Then, an initial value perturbation problem is considered; this case is of some more general interest as an example of a perturbation solution involving a sonic line and uses the PLK-technique. Alternatively, a boundary perturbation problem for supersonic flow is presented. Finally, the application of the methods developed to the central problem of the design of a Laval nozzle with a partially prescribed contour is discussed, and a practical example given. Some numerical aspects are discussed. Author

N67-36152# Ministry of Technology, London (England). Aeronautical Research Council.
DETERMINATION OF STAGNATION TEMPERATURES IN THE R.A.R.D.E. HYPERSONIC GUN TUNNEL FROM STREAK CAMERA MEASUREMENTS OF FLOW VELOCITY
J. E. Bowman HMSO, 1967 20 p refs Supersedes RARDE-MEMO-2/66; ARC-27768; See X66-17940
(ARC-CP-929; RARDE-MEMO-2/66; ARC-27768) CFSTI: HC $3.00/MF$0.65

Flow velocities in the working section of the hypersonic gun tunnel have been measured by a streak camera method for flow Mach numbers of 8.4, 10.4 and 12.9 and initial breech/barrel pressure ratios ranging from 25 to 300, using nitrogen as the driving gas and both air and nitrogen as working gases. Stagnation temperatures calculated from the measured flow velocities ranged from about 750°K to 1600°K and were up to 15% higher than corresponding real-gas isentropic temperatures. Cooling rates were of the order 2°K per millisecond. Results for air and nitrogen were generally similar near the beginning of a run, but towards the end of the run a marked increase in flow velocity was observed with air. This was attributed to partial combustion of the nylon piston. Author

N67-36179# National Aeronautics and Space Inst., Bandung (Indonesia).
INDONESIA'S FIRST SPACE CENTER
[1967] 9 p refs Presented at the IQSY-COSPAR Symp., London, Jul. 1967
(Rept.-4)

Indonesia's space center and its associated ground support equipment, launch complex, and equipment for rocket-grenade soundings are briefly described. The ground equipment discussed includes a tracking radar system, telemetry system, optical tracking system, and launch control system. Advantages and disadvantages of the site are mentioned. R.N.A.

N67-36204*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
SPACE MOLECULAR SINK SIMULATOR FACILITY
J. B. Stephens *In its* 2d Aerospace Mech. Symp. 15 Aug. 1967 p 1–8 ref (See N67-36203 21-31)

The results of research, design, and development efforts for a space molecular sink simulation facility now under construction are summarized. The chamber wall shrouds capture 99.97% of most of the gases that emanate from a test item. Cryogenic quartz crystal microbalances will be used to measure the molecular fluxes from the test item, and a mass spectrometer will be used to identify them. Author

N67-36287# Gt. Brit. National Inst. for Research in Nuclear Science, Chilton. Rutherford High Energy Lab.
A STUDY OF THE FEASIBILITY OF TRANSPORTING THE BEAM FROM THE 50 MeV PLA FOR INJECTION INTO NIMROD
C. W. Planner Dec. 1966 35 p refs
(RHEL/R-141) CFSTI: HC$3.00/MF$0.65

From the study described it is concluded that transport of a 50-MeV beam from the Proton Linear Accelerator to Nimrod, with an acceptable beam profile, is technically feasible (both machines being situated in their present positions). The resulting

increase in injection energy, from 15 MeV to 50 MeV, should increase the space charge limitation of the synchrotron by a factor of 3. Since the first bending magnet of the proposed transport system is of small angle, it should be possible to pulse this magnet and thus allow 50 MeV beams to be switched between Nimrod and the PLA experimental area. Overhead and underground beam transport systems are considered. A cost estimate is given and compared with that for rehousing and rebuilding the PLA adjacent to the present 15 MeV injector. NSA

N67-36292# California Univ., Berkeley. Lawrence Radiation Lab.
TARGETRY USED ON THE BEVATRON TO EXACT SECONDARY EXPERIMENTAL BEAMS
Kenneth F. Stone 10 Nov. 1966 13 p Presented at the Natl. Particle Accelerator Conf., Washington, D. C., 1–3 Mar. 1967
(Contract W-7405-ENG-48)
(UCRL-17278; CONF-670307-47) CFSTI: HC $3.00/MF $0.65

The development of target drive mechanisms at the Bevatron, with the final evolution of the present high-speed mechanism are discussed. The early target drives, used in the main circulating beam channel, could raise a 1-lb target head 5-1/2 in. in 100 ms. The present high-speed target drive is designed to raise a 1/2-lb target head 1-1/2 in. in 10 ms. The higher-speed mechanism became desirable with increased beam control, allowing for flat topping and splitting individual Bevatron beam pulses between two or more experimenters. All designs are intended for performance in the high vacuum of the accelerating chamber. Author (NSA)

N67-36299# Washington Univ., Seattle.
TERMINAL VOLTAGE FLUCTUATIONS OF AN FN TANDEM VAN DE GRAAFF ACCELERATOR
H. Fauska, J. S. Heagney, T. J. Morgan, and F. H. Schmidt [1967] 8 p refs Presented at the Natl. Particle Accelerator Conf., Washington, D. C., 1–3 Mar. 1967
(Contract AT(45-1)-1388)
(RLO-1388-22; CONF-670307-54) CFSTI: HC $3.00/MF $0.65

The terminal potential of an FN tandem Van de Graaff accelerator fluctuates by 500 to 1000 volts. The repetitive character of the fluctuates indicates that the cause lies in inhomogeneities of the belt. Evidence is presented indicating that the inhomogeneities probably arise from the manner in which the rubber–impregnating compound on the belt is cured. A simple method for reducing the effects of these inhomogeneities is suggested. NSA

N67-36434# California Univ., Berkeley. Lawrence Radiation Lab.
SELECTION OF INJECTOR SYNCHROTRON PARAMETERS TO MINIMIZE COST OF THE 200-GeV ACCELERATOR
F. B. Selph and J. M. Peterson 17 Feb. 1967 12 p refs Presented at the Natl. Particle Accelerator Conf., Washington, D. C., 1–3 Mar. 1967
(Contract W-7405-ENG-48)
(UCRL-17191; CONF-670307-52) CFSTI: HC $3.00/MF $0.65

In choosing the type of injector system and in optimizing the parameters of any given type of system, the relative cost advantages as well as relative technical advantages eventually entering into the arguments are considered. A method of determining the cost of accelerator systems is discussed and some examples that arose in the selection of an injector system for the proposed 200-GeV accelerator are given. The cost of the injector system cannot be considered apart from the total accelerator cost because the aperture of the main ring depends upon the energy and emittance of the beam transferred from the injector. Since the main ring is relatively much larger and more expensive than the injector system, a change which lowers injector cost can cause a much larger increase in main ring cost. Author (NSA)

N67-36435# California Univ., Berkeley. Lawrence Radiation Lab.
RADIATION PROBLEMS WITH HIGH-ENERGY PROTON ACCELERATORS
William S. Gilbert 21 Feb. 1967 18 p refs Presented at the Natl. Particle Accelerator Conf., Washington, D. C., 1–3 Mar. 1967
(Contract W-7405-ENG-48)
(UCRL-17141; CONF-670307-53) CFSTI: HC $3.00/MF $0.65

A discussion is presented on proton accelerators in the multi-GeV energy range and of the alternating-gradient synchrotron type, with special attention given to the existing 30-GeV and the proposed 200- to 300-GeV machines. Radiation problems can be divided into two broad groups: those produced by the accelerator while it is running and those associated with the shut-down machine. The expense and difficulty of coping with these radiation problems influence the choice of design beam intensity. The problems while the machine is running are penetration of radiation through the shielding, muon shielding, penetration of radiation through ducts and labyrinths, skyshine, diffusion of radioactive air, and radiation damage to components. Some results of an LRL-CERN-Rutherford shielding experiment on the CERN-PS are presented. Problems of the shut-down accelerator include induced activity in the machine components and enclosure walls. These radiation fields affect maintenance procedures and require appropriate handling tools and shielded vehicles. Author (NSA)

N67-36508# Air Force Systems Command, Wright-Patterson AFB, Ohio. Air Force Dynamics Lab.
DIGITAL SIMULATION OF A GAUSSIAN RANDOM PROCESS HAVING AN EXPONENTIAL AUTOCORRELATION FUNCTION Final Report, Jul. 1964–Aug. 1966
David K. Bowser and George R. Schubert May 1967 49 p refs
(AFFDL-TR-67-52; AD-654643)

The digital simulation of terrain or longitudinal gust profiles is shown to be practical. Its use as input to an overall system simulation has reasonable promise of success. With the tools developed in this report, the user has at his disposal a means of determining what is a reasonable choice for the numerical integration increment and what is a sufficient sample length in a statistical sense. Author (TAB)

N67-36528# Sylvania Electric Products, Inc., Needham, Mass. Sylvania Electronic Systems-East.
SPLIT FUNCTION GENERATION STUDY Final Report
Janice Rossbach and Henry J. Wychorski Orlando Fla., Naval Training Device Center, May 1967 81 p refs
(Contract N61339-1823)
(NAVTRADEVCEN-1823-1; AD-655107)

A study was conducted to determine function splitting modes for flight simulation which reduce computation time of function generation without deterioration of simulation quality. Analytical and experimental methods were developed for selecting and evaluating split function modes. Split function modes were tested on UDOFTT (Universal Digital Operation Flight Trainer Tool) using a program written during the study. The Split Function Evaluation Program provides a means of comparing flight simulation using a function splitting mode with a complete simulation in which all functions are computed during each cycle. Results of the study indicate that, for the short term longitudinal response of the aircraft simulated, the function generation interval can be increased to 1.5 seconds without significant deterioration of simulation quality except for functions comprising the critical coefficient. If functions comprising the critical coefficient are updated less frequently than .5 seconds, simulation quality may deteriorate. Author (TAB)

N67-36562# Comision Nacional de Energia Atomica, Buenos Aires (Argentina).
DATA ON BUENOS AIRES SYNCHROCYCLOTRONS FOR THE YEARS OF 1954–1965 [EL SINCROCICLOTRON DE BUENOS AIRES INFORME RETROSPECTIVO PERIODO 1954–1965]
1966 34 p refs In SPANISH
(CNEA-188)

Since its opening in 1954 the synchrocyclotron laboratory has offered facilities first for studies in nuclear chemistry, then in nuclear physics, and most recently in nuclear biology. A general description is given of the laboratory. A bibliography is given of the completed nuclear physics, chemistry, and biological problems studied. (NSA)

N67-36579# Massachusetts Inst. of Tech., Cambridge.
CENTRAL FACILITIES OF THE INTERDISCIPLINARY LABORATORY FOR MATERIALS RESEARCH
In its Res. in Mater. Sci. and Eng. Apr. 1967 p 399–409 (See N67-36571 21-26)

Facilities for general services, specialized research, and materials preparation and processing are described. The last has capabilities for insulating, optical and semiconducting crystal growth; metal crystal growth and preparation; and ceramic materials processing. Specialized facilities are for microscopy and metallography, X-ray and electron optics, X-ray and low energy electron diffraction, and gas analyzer mass spectrometry investigations. M.W.R.

N67-36617# California Univ., Berkeley. Lawrence Radiation Lab.
SOME RECENT DEVELOPMENTS IN VACUUM TECHNIQUES FOR ACCELERATORS AND STORAGE RINGS
Norman Milleron Mar. 1967 23 p refs Presented at the Particle Accelertor Conf., Washington, D. C., 1–3 Mar. 1967
(Contract W-7405-ENG-48)
(UCRL-17296; CONF-670307-50) CFSTI: HC $3.00/MF $0.65

A review of ultrahigh vacuum problems peculiar to accelerators and storage rings is presented. Topics discussed are vacuum pumps, beam interactions with gases, pumpdown results, repairing of leaks during pump tests, recovery from accidents and malfunctions, weld and cut joints, and alumina beam tube. NSA

N67-36649# Paris Univ., Orsay (France). Laboratoire de l'Accelerateur Lineaire.
INJECTION IN THE ORSAY COLLISION RINGS [L'INJECTION DANS L'ANNEAU DE COLLISION D'ORSAY]
R. A. Beck, G. Gendreau, J. Haissinski, and P. C. Marin Feb. 1967 11 p refs In FRENCH Submitted for publication
(LAL-1170)

The injection system used at the Orsay collision rings is a multirevolution injection system making use of a walled magnetic inflector. The injected particles spiral toward the center of the chamber under the influence of a variable deflecting field furnished by the perturbator placed in the section opposite to the injection section. Experimental data show that nonlinearity and resonances play a primary role in the injection mechanism. The nonlinearity responsible for the dependence of the betatron wave numbers on the energy and the amplitude and the inevitable presence of resonances explain the injection yield measured on the storage ring. NSA

N67-36652# Akademiya Nauk SSSR, Novosibirsk. Institut Yadernoi Fiziki.
A DEVICE FOR THE MEASUREMENT OF COHERENT RADIAL-PHASE OSCILLATION PARAMETERS IN COLLIDING STORAGE RINGS [PRIBOR DLYA IZMERENIYA PARAMETROV KOGERENTNYKH RADIAL'NO-FAZOVYKH KOLEBANII V NAKOPITELYAKH USTANOVOK SO VSTRECHNYMI PUCHKAMI]
E. A. Pirushkin and T. P. Starodubtseva 1965 12 p refs In RUSSIAN
(NP-16690)

A method for the measurement of the phase displacement between the first harmonic of the signal directed with the beam on the electrostatic electrode, and the voltage on the resonator in the angular range from 0 to 360° with a precision of 0.5° at resolving capacities of 0.1° was described. The method can be used for the measurement of the coherent loss in the VEPP-2 storage ring and during recording of the collision of two brief bursts. Author (NSA)

N67-36657# European Organization for Nuclear Research, Geneva (Switzerland).
REPORT ON THE DESIGN STUDY OF A LARGE HYDROGEN BUBBLE CHAMBER FOR THE CERN PROTON SYNCHROTRON
Oct. 1966 144 p refs
(CERN/TC/BEBC-66-73)

The physics aspects, construction program, and the budget of a large hydrogen bubble chamber for the CERN proton synchrotron are discussed. NSA

12 FLUID MECHANICS

Includes boundary-layer flow; compressible flow; gas dynamics; hydrodynamics; and turbulence. For related information see also: 01 Aerodynamics; and 33 Thermodynamics and Combustion.

N67-35347# Cornell Aeronautical Lab., Inc., Buffalo, N. Y.
VIBRATIONAL RELAXATION OF ANHARMONIC OSCILLATORS
Joseph W. Rich and Ronald G. Rahm May 1967 52 p refs
(Contract AF 49(638)-1488)
(CAL-AF-2022-A-2; AFOSR-67-1180; AD-654486) CFSTI: HC $3.00/MF $0.65

The terms in the master equation for vibrational relaxation of anharmonic oscillators are ordered according to the rates of the relaxation processes (vibrational exchange, vibrational-energy transfer to translation). A perturbation procedure is developed by making use of the fact that the vibration-translation energy exchange transitions are much slower than the vibration-vibration transitions. The population distributions in the master equation are expanded about their values when the vibration-vibration mechanism is the only one present. To zeroth order, the master equation is satisfied by a distribution derived previously by Treanor for anharmonic oscillators. This distribution is maintained by vibration-vibration exchange, and is only Boltzmann during relaxation in the limit of vanishing anharmonicity. The perturbation on this distribution, created by vibration energy transfer to translation, is calculated to first order for a special case. The relaxation of the first moment of the zeroth-order distribution function is also investigated. The population of the lowest vibrational states can be considerably lower than the population predicted by the Landau-Teller model for the relaxation process. Furthermore, since the inversion tends to weight those states having fast vibration-to-translation energy transfer rates, the overall energy relaxation rate can be accelerated. Author (TAB)

N67-35464# Institut Franco-Allemand de Recherches, St. Louis (France).
A PROCESS FOR MEASURING THE VELOCITY VARIATION OF SHOCK WAVES USING MICROWAVES [EIN VERFAHREN ZUR MESSUNG DES GESCHWINDIGKEITSVERLAUFES VON STOSSWELLEN MIT HILFE VON MIKROWELLEN]

M. Koenig and B. Koch 13 Aug. 1965 17 p refs In GERMAN
(ISL-T-26/65) CFSTI: HC $3.00/MF $0.65

Described is the experimental arrangement for the continuous measurement of the velocity of shock waves produced in a membrane shock tube. The system operates with digital counters, and it is based on the Doppler effect of the microwave reflected by the ionized shock front. Examples of application are discussed for measuring air shock waves down to Mach 8. The relative accuracy of the single velocity measurement at a given point is of the order of several 10^{-3}. Transl. by K.W.

N67-35564# California Univ., Berkeley. Aeronautical Sciences Div.

A LINEARIZED SOLUTION OF THE CONSTANT-PRESSURE COMPRESSIBLE FAR WAKE

F. Talke and S. A. Berger Apr. 1967 32 p refs
(Contract Nonr-222(45))
(AS-67-5; AD-654928)

The report describes the numerical solution of the linearized differential equations governing compressible axisymmetric laminar wake flows. Starting with experimentally determined initial profiles slightly downstream of the rear stagnation point, profiles of velocity and enthalpy were computed for the entire downstream wake. Comparison with the measured values showed very good agreement, the maximum error between theory and experiment being always less than 10 percent. Author (TAB)

N67-35598# Naval Radiological Defense Lab., San Francisco, Calif.

RELATIVE MOTION AND COAGULATION OF PARTICLES IN A TURBULENT GAS

Ian O. Huebsch 4 May 1967 112 p refs
(USNRDL-TR-67-49; AD-655150)

The existing theory of turbulent-accelerative coagulation applies only to particles so small that they respond to all fluid motions, including those of the smallest, most rapidly accelerating eddies (microscale eddies). The maximum particle diameter for which this theory applies is typically 5 to 10 microns. A review of coagulation and small-scale turbulence theory showed that the theory of turbulent-accelerative particle motion relative to the fluid and coagulation may be extended to particles whose relaxation times are greater than the period of microscale eddies. The extension is based on the concept that each such particle moves at a characteristic speed relative to the fluid, corresponding to the speed of the eddy size whose period equals the particle relaxation time. Thus for each particle size there is a resonant eddy size. Different coagulation mechanisms were compared. Apparently the only situation in which turbulent-accelerative coagulation can be more important than gravitational coagulation, is in nuclear-explosion clouds. A method of numerical computation of coagulation due to all the mechanisms cited was developed. Author (TAB)

N67-35632# Atomic Weapons Research Establishment, Aldermaston (England).

THE INTERACTION OF A LONG DURATION FRIEDLANDER SHAPED BLAST WAVE WITH AN INFINITELY LONG RIGHT CIRCULAR CYLINDER. INCIDENT BLAST WAVE 20.7 PSI, POSITIVE DURATION 50 MS AND A 16 CM DIAMETER CYLINDER

Valerie J. Bishop and R. D. Rowe Apr. 1967 61 p refs
(AWRE-O-38/67) CFSTI: HC $3.00/MF $0.65

Studies of the effect of subjecting a 16 cm diameter infinite cylinder to a 50 ms duration Friedlander shaped blast wave, 20.7 psi peak shock overpressure, at a maximum Reynolds number of 3.75×10^6 and Mach number of 0.6, are reported. Piezoelectric pressure gauge measurements were used to compute pressure coefficient, average translational force, and drag coefficient. From this work, it was concluded that the shapes of the pressure coefficient-time curves obtained show general agreement with steady state work and their values are of the same order of magnitude. The drag coefficients computed, except for the initial shock-interaction phase, are of the same order of magnitude as the steady state values obtained for comparable Reynolds and Mach numbers. Author (NSA)

N67-35670 Imperial Coll. of Science and Technology, London (England). Dept. of Mechanical Engineering.

THE NUMERICAL SOLUTION OF THE EQUATIONS OF FLOW IN THE INITIAL REGION OF A WALL JET

M. Wolfshtein May 1967 47 p refs
(SF/TN/7)

A general method and a computer program for the solution of the elliptic equations of conservation of momentum, heat, and matter, published elsewhere, have been adapted to the use of a plane turbulent jet running parallel to a wall. Thus predictions may now be made for the flow in the initial region of a wall jet, which does not yield to the usual boundary layer treatments. Author

N67-35681# Stanford Univ., Calif. Dept. of Civil Engineering.

TECHNIQUES FOR SOLVING FREE-STREAMLINE, CAVITY, JET AND SEEPAGE PROBLEMS BY FINITE DIFFERENCES

Roland W. Jeppson Sep. 1966 318 p refs
(Contract Nonr-225(56))
(TR-68; AD-654922)

Free surface problems in seepage through porous media (governed by Darcys Law), and plane and axisymmetric idealized jets and cavities were solved by the methods of finite differences. The problems were solved by considering the stream function and the velocity potential as the dependent variables, the rectangular coordinates x and y or the cylindrical coordinates r and z, or other quantities such as the velocity and direction of flow as the dependent variables. Example solutions to the following problems are given: (1) Plane seepage flow through a homogeneous, isotropic or anisotropic dam on an impervious foundation with a toe drain. (2) Plane seepage from ditches of trapezoidal, triangular or rectangular sections through porous media consisting of one or two isotropic or anisotropic layer to a drained layer. (3) Plane cavitating flow of an inviscid, incompressible free jet of liquid past a body. (4) Plane cavitating flow of a body in an open channel with or without gravity in the transverse direction. (5) Axisymmetric cavitating flow of a jet of liquid past a body of revolution. (6) Axisymmetric flow of a liquid from a converging nozzle. Author (TAB)

N67-35710# Marine Engineering Lab., Annapolis, Md.

THE CONFINED VORTEX BETWEEN TWO FIXED CONCENTRIC CYLINDERS: A THEORETICAL STUDY OF VAPOR FLOW IN A SURFACE CONDENSER

C. K. Tsao Mar. 1967 42 p refs
(MEL-461/66; AD-655131) CFSTI: HC $3.00/MF $0.65

The vapor flow in a submarine surface condenser was theoretically analyzed for the case where only the exhaust steam from the ships service turbo-generator enters the condenser. The mathematical model of this vapor flow represents a confined vortex flow between two concentric fixed cylinders. To simulate the condenser tube bundle, the inner cylinder was assumed to have a porous wall. The flow equations for this geometry were developed for an incompressible gas in steady flow. Two types of gas extraction were evaluated: uniform extraction over the porous surface and extraction that is variable with distance along the porous cylinder. Because the resulting flow equations could not be solved in closed form, numerical analysis was applied. Vapor flow patterns for uniform versus variable extraction were compared by calculating a specific numerical example. The results of the analysis emphasized the need for experimental data to develop an equation to accurately describe the extraction process. Author (TAB)

N67-35714# Polytechnic Inst. of Brooklyn, Farmingdale, N. Y. Dept. of Aerospace Engineering and Applied Mechanics.
DIFFERENCE METHODS FOR THE INVISCID AND VISCOUS EQUATIONS OF A COMPRESSIBLE GAS
Samuel Z. Burstein and (New York Univ.) and Ephraim L. Rubin Jun. 1967 41 p refs
(Contract Nonr-839(34); AT(30-1)-1480)
(PIBAL-989; AD-655113)

An examination was made of several second-order accurate schemes for the solution of one-dimensional flows containing discontinuities. Two problems of shock interactions were considered, and two generalizations of these schemes were used for the solution of the Navier-Stokes equations. Author (TAB)

N67-35723*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
NUMERICAL RESULTS FOR THE DIFFRACTION OF A NORMAL SHOCK WAVE BY A SPHERE AND FOR THE SUBSEQUENT TRANSIENT FLOW
Richard W. Barnwell Washington, NASA, Sep. 1967 38 p refs
(NASA-TR-R-268) CFSTI: HC$3.00/MF$0.65 CSCL 20D

The finite difference method, developed for treating unsteady inviscid flow fields, is used to study the transient flow in the shock layer of a sphere that has been struck by a normal shock wave. Transient flow of this sort is encountered when a shock tube is used as a supersonic wind tunnel. Time histories of the shock detachment distance and the stagnation-point pressure and tangetial velocity gradient are presented for ranges of the incident-shock Mach number and the perfect-gas specific-heat ratio. These results show that the stagnation-point pressure approaches the steady value much more rapidly than the shock detachment distance. In general, the stagnation-point tangential velocity gradient approaches the steady value less rapidly than stagnation-point pressure but more rapidly than the shock detachment distance. As the specific-heat ratio is decreased and the incident-shock Mach number is increased, the variation of the velocity gradient with respect to the shock detachment distance becomes more nearly linear. Author

N67-35737*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
PHOTOGRAPHIC INVESTIGATION OF LIQUID BEHAVIOR ON TEMPERATURE AND LIQUID-VAPOR SENSORS USED IN LOW-GRAVITY ENVIRONMENT
James A. Berns, Frederick C. Yeh, and Ralph C. Nussle Washington, NASA, Sep. 1967 27 p refs
(NASA-TM-X-1438) CFSTI: HC$3.00/MF$0.65 CSCL 21H

In developing the capability to restart a liquid-fueled rocket after a period of coasting in orbit, it is of prime importance to know the distribution of the propellant in the tank. Liquid-vapor sensors were installed in the liquid-hydrogen tank on an Atlas–Centaur rocket (AC-8) to aid in determining the location of the propellant. Since such sensors could be subject to erroneous liquid indications because of bulk liquid clinging to the sensing tip even in a vapor environment, an experimental laboratory study of the sensing tip was conducted under simulated coasting flight conditions. The results of the investigation indicate that surface tension will cause a wetting liquid to migrate in the direction of increasing radius on a conical surface when in a zero-gravity environment. The sensor should be mounted in such a position that any system acceleration would also cause liquid to move in the direction of increasing radius. These two forces, surface tension and acceleration, would then combine to prevent any collection of liquid on the sensing tip of the cone. Also, any abrupt discontinuities on the surface will act as liquid collectors. Author

N67-35763*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
CORRELATION OF FRICTION COEFFICIENTS FOR LAMINAR AND TURBULENT FLOW WITH RATIOS OF SURFACE TO BULK TEMPERATURE FROM 0.35 TO 7.35
Maynard F. Taylor Washington, NASA, Sep. 1967 20 p refs
(NASA-TR-R-267) CFSTI: HC$3.00/MF$0.65 CSCL 20D

The existing conventional methods of correlating and predicting friction coefficients for laminar and turbulent flow are shown to give friction coefficients that are in poor agreement with the measured values for large ratios of surface to fluid-bulk temperature. The local and average friction coefficients used were for laminar and turbulent flow of helium, hydrogen, nitrogen, carbon dioxide, and air through smooth tubes. Inside diameters varied from 0.115 to 0.569 inches (0.292 to 1.445 cm); ratios of surface to fluid-bulk temperature ranged from 0.35 to 7.35; and modified surface Reynolds numbers ranged from 170 to 550,000. The recommended correlation equation for modified surface Reynolds numbers less than 3000 is $f/2 = 8/Re_s$, where $f/2$ is half friction coefficient and Re_s is the modified surface Reynolds number. For modified surface Reynolds numbers of 3000 or greater, the recommended correlation is $f/2 = (0.0007 + 0.0625/Re_s^{0.32})(T_b/T_s)^{0.5}$, where T_b and T_s are the bulk and surface temperatures, respectively. The foregoing smooth tube relations also correlated laminar and turbulent friction coefficients for flow between parallel plates. Author

N67-35877# Los Alamos Scientific Lab., N. Mex.
LAMINAR-NONLAMINAR TRANSITION FOR NON-NEWTONIAN FLOW IN ANNULI
Donald W. McEachern 28 Nov. 1966 21 p refs Presented at the 62d Natl. Meeting of the Am. Inst. of Chem. Engr., Salt Lake City
(Contract W-7405-ENG-36)
(LA-DC-8679; CONF-670506-2) CFSTI: HC$3.00/MF$0.65

Experimental results on the laminar–nonlaminar transition of aqueous solutions of hydroxyethyl cellulose in axial, isothermal flow in annuli are presented. For each polymer solution the end of the laminar regime is observed to occur at different flow rates at different axial distances from the entrance of the test section. For some polymer solutions in nonlaminar motion, the pressure gradient is not constant over the length of the test section. These data on transition in annuli are compared with predictions made using Hanks' transition criterion where (1) only viscous contributions are considered and (2) where viscous effects are considered and elastic effects accounted for approximately. Predictions where both viscous and elastic properties of the fluids are considered are in fair agreement with experiments. Predictions using purely viscous theory are less accurate. Author (NSA)

N67-35892* Heat Technology Lab., Inc., Huntsville, Ala.
DETERMINATION OF THE CAPTURE COEFFICIENT OF A HIGHLY DIRECTED FLOW OF GASEOUS CARBON DIOXIDE AND WATER VAPOR ON A LIQUID NITROGEN COOLED SURFACE, VOLUME II Final Report
W. W. Youngblood 27 Jan. 1967 refs
(Contract NAS8-20554)
(NASA-CR-88267; HTL-TR-38, Vol. II) CSCL 20D

A cryogenic quartz crystal microbalance was used to determine the capture coefficient for a highly directed, rarefied flow of gaseous carbon dioxide and a randomized flow of both carbon dioxide and water vapor. The highly directed flow of gaseous carbon dioxide was provided by a continuum source molecular beam and was allowed to impinge on a liquid nitrogen cooled quartz crystal. The capture coefficient was determined to be 0.75 in the present tests. The capture coefficients were also determined for randomized fluxes of gaseous carbon dioxide and water vapor under a vacuum bell jar. The capture coefficients determined in these tests were 0.75 and 0.79 for gaseous carbon dioxide and water vapor, respectively. The technique of monitoring deposit thickness buildup

using a cryogenic quartz crystal microbalance is suggested as a possible means of measuring the intensity of low energy molecular beams. Author

N67-35901# Advisory Group for Aerospace Research and Development, Paris (France).
DISCUSSIONS FOLLOWING THE PRESENTATIONS OF PAPERS AT THE AGARD FLUID DYNAMICS SPECIALISTS' MEETING ON "SEPARATED FLOWS"
Jean Ginoux, ed. and Helmut Uebelhack, ed. 1966 51 p refs Meeting held in Rhode-Saint-Genese, Belgium, 10–13 May 1966
(AGARD-CP-4, Suppl.; AD-654539)

The purpose of the meeting was to review and discuss general and practical problems in separated flows from low to hypersonic speeds, to present a good cross-section of the current state-of-the-art, and to provide guidance for future research and development. Author (TAB)

N67-35937*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
HEAT TRANSFER IN 30° AND 60° HALF-ANGLE OF CONVERGENCE NOZZLES WITH VARIOUS DIAMETER UNCOOLED PIPE INLETS
Donald R. Boldman, Harvey E. Neumann, and James F. Schmidt Washington, NASA, Sep. 1967 45 p refs
(NASA-TN-D-4177) CFSTI: HC $3.00/MF $0.65 CSCL 20M

An experimental investigation was conducted in a heated-air facility in order to determine the effects of a variation in uncooled pipe-inlet diameter and the associated contraction area ratio on the heat-transfer distributions in 30° and 60° half-angle of convergence nozzles having the same throat diameter and curvature. Tests were conducted at a nominal stagnation temperature of 970°R (539°K) and nominal stagnation pressures of 160 and 300 lb/in^2 (110 and 207 N/cm^2) absolute. Experimental heat-transfer coefficients were compared to values predicted by two interrelated boundary-layer calculation techniques and a pipe-flow (Nusselt number) type of correlation. Pronounced increases in the experimental nozzle peak heat-transfer coefficients accompanied a reduction in contraction area ratio, other conditions remaining fixed. For the same contraction area ratio and stagnation conditions, a pronounced increase in peak heat-transfer coefficient was coincident with an increase in nozzle convergence angle. All the prediction techniques failed to yield consistent agreement with the experimental peak heat-transfer coefficients; that is, in some cases all methods underestimated the peak values of heat-transfer coefficient, but in other cases an overprediction was evident. The overpredicted heat transfer was usually characteristic of the configurations having the largest contraction area ratio (≈19). Author

N67-35940# California Univ., Berkeley. Aeronautical Sciences Div.
AN INVESTIGATION ON THE LAMINAR FLOW AROUND THE TRAILING EDGE OF A FLAT PLATE
Ralph Ta-shun Cheng May 1967 103 p refs
(Contract Nonr-222(45))
(AS-67-8; AD-654930)

Studies of the incompressible fluid motion around a two-dimensional flat plate aligned parallel to the oncoming free stream are thoroughly reviewed and extended. Emphasis is placed on the detailed study of the fluid motion in the neighborhood of the trailing edge. A modified Oseen linearization is used to simplify the Navier-Stokes momentum equations and the stream function equation. These equations are then solved by the Wiener-Hopf technique. The solution of the momentum equations confirms the existence of a singularity at the trailing edge, and the distribution of shear stress on the plate is in agreement with a recent numerical solution. The stream function equation, however, is only formally solved. Finally, an iterative procedure is proposed to solve the viscous fluid motion around an arbitrary two-dimensional finite object. Specifically, the full Navier-Stokes equations are written in the form of inhomogeneous Oseen equations and higher orders of the asymptotic stream function are then determined by solving the inhomogeneous equations with lower order terms substituted in the inhomogeneous part of each of the equations. Greens function is found for the Oseen operator, but no specific example is given in the study. Author (TAB)

N67-36108* Scientific Translation Service, La Canada, Calif.
DAMPING OF SHOCK WAVES IN NONUNIFORM MEDIA [ZATUKHANIYE UDARNYKH VOLN V NEODNORODNYKH SREDAKH]
O. S. Ryzhov Washington, NASA, Sep. 1967 16 p refs Transl. into ENGLISH from Zh. Prikl. Mekhan. i Techn. Fiz. (Moscow), no. 2, 1961 p 15–25
(Contract NASw-1496)
(NASA-TT-F-11247) CSCL 20D

An approach similar to that of L. D. Landau is used to take into account nonlinear effects when shock waves are propagated in a nonuniform medium. The problem of interaction of two shock waves in a nonuniform medium is investigated when one shock wave overtakes another. Author

N67-36110* Farnham (Frank C.) Co., Philadelphia, Pa.
VISCOSITY COEFFICIENTS OF SUBSTANCES CLOSE TO THE CRITICAL STATE [PRO KOEFITSIYENTY V'YAZKOSTI RECHOVYNY POBLYZU KRYTYCHNOHO STANU]
I. Z. Fisher and Yu. P. Krasnyy Washington, NASA, Jul. 1967 7 p refs Transl. into ENGLISH from Ukr. Fiz. Zh. (Kiev), v. 12, no. 1, 1967 p 10–14
(Contract NASw-1497)
(NASA-TT-F-11101) CSCL 20D

Investigation of the spatial dispersion of the viscosity coefficients of liquids near the critical points. It is shown that the bulk viscosity near the critical point is proportional to the Fourier paired correlation function $\nu(\vec{k})$ and at $|\vec{k}| \to 0$ has the same properties as $\nu(\vec{k})$. Owing to the fact that the shear viscosity coefficient $\eta(\vec{k})$ increases sharply in the critical state, it is concluded that $\eta(\vec{k})$ has a pole no higher than the second order at $|\vec{k}| \to 0$. Author

N67-36111 Imperial Coll. of Science and Technology, London (England). Dept. of Mechanical Engineering.
WALL-SHEAR-STRESS AND HEAT-FLUX LAWS FOR TURBULENT BOUNDARY LAYER WITH A PRESSURE GRADIENT: USE OF VAN DIREST'S EDDY–VISCOSITY HYPOTHESIS
S. V. Patankar May 1966 32 p refs
(TWF/TN/14)

Van Driest's hypothesis for the variation of the total viscosity in a turbulent flow near a wall has been used to obtain exact numerical solutions for uniform-property Couette flow in the presence of a pressure gradient. Explicit analytical formulas are obtained which closely fit these solutions; the formulas express the shear stress and the heat flux at the wall in terms of the velocity and the temperature of a point in the fluid, the distance of that point from the wall, the longitudinal pressure gradient, and the fluid properties. These formulas can be used in integral methods of boundary-layer calculation. It is pointed out that, though a partial justification exists for this hypothesis, and though the new formulas seem to express the influence of pressure gradient with qualitative correctness, confirmatory experiments are needed. Author

N67-36140# Bettis Atomic Power Lab., Pittsburgh, Pa.
FLOW PATTERNS IN HIGH PRESSURE TWO-PHASE (STEAM–WATER) FLOW WITH HEAT ADDITION
E. R. Hosler Jan. 1967 42 p refs Presented at 9th Natl. Heat Transfer Conf., Seattle
(Contract AT(11-1)-GEN-14)
(WAPD-T-1824; CONF-670807-1) CFSTI: HC $3.00/MF $0.65

The flow patterns that occur in forced flow vaporization of water at high pressure were observed and photographed. A vertical rectangular channel 1/8 in. thick × 1.0 in. wide × 24 in. long heated from one side, the other three sides being used for observation of the flow phenomena, was used for the experimental investigation. The ranges of variables covered include: pressure 150 to 2000 psia; mass velocity 0.10×10^6 to 4.0×10^6 lb/hr-ft^2; heat flux up to 1.8×10^6 Btu/hr-ft^2; quality subcooled to 0.70. The flow patterns observed included bubble, slug-type, annular, spray-annular, and wave flow. Comparisons were made between observed flow pattern transitions and several published flow pattern maps, based generally on adiabatic flow. The differences between two-phase adiabatic flow and two-phase flow with heat transfer are noted. Preliminary empirical flow regime maps for use with narrow rectangular channels are presented. Author (NSA)

N67-36145*# National Aeronautics and Space Administration, Washington, D. C.
CONTRACTION COEFFICIENT OF JETS [O KOEFFITSIYENTE SUZHENIYA STRUY]
Yu. P. Ivanilov and Ye. V. Semenov Aug. 1967 8 p refs Transl. into ENGLISH from Izv. Akad. Nauk SSSR, Mekhan. Zhidkosti i Gaza (Moscow), no. 1, 1967 p 118–122
(NASA-TT-F-11150) CFSTI: HC $3.00/MF $0.65 CSCL 20D

Asymptotic exponential laws of the contraction of plane and axisymmetric jets of weightless fluids at large distances from the nozzle were determined. The surface tension forces are neglected. Expressions for the stream function and the velocity components of the fluid at the free surface of the jet are derived for a variety of fluid and flow parameters. Author

N67-36170 Israel Inst. of Tech., Haifa. Dept. of Aeronautical Engineering.
RAREFIED FLOW PROBLEMS BY MOLECULAR DYNAMICS
E. Wasserstrom Jun. 1967 20 p refs
(TAE-69)

Rarefied flows are studied by considering the detailed motion of the molecules using an electronic computer. The simple example of the relaxation of a two-dimensional hard-sphere gas to equilibrium is considered. It is shown that the equilibrium Maxwell–Boltzmann distribution is reached after few mean free times. Author

N67-36171*# California Univ., Los Angeles. Dept. of Engineering.
A STUDY OF ROTATIONAL RELAXATION IN A LOW-DENSITY HYPERSONIC FREE JET BY MEANS OF IMPACT-PRESSURE MEASUREMENTS
B. Lefkowitz Jul. 1967 62 p refs
(Grants NsG-237-62; NSF GK-580)
(NASA-CR-88364; Rept.-67-27) CFSTI: HC $3.00/MF $0.65 CSCL 20D

A hypersonic free jet of nitrogen was probed using a pitot tube. The impact pressure was found to deviate from predictions of inviscid theory for free jets (after corrections for shock detachment, nozzle boundary layer, and viscous effects at the probe) in regions of rotational nonequilibrium. The rotational relaxation time was inferred from the impact pressure data by the use of the criterion for sudden freezing $|DT/Dt| = T/\tau_r$. The observed relaxation time was interpreted using a relaxation model in which N_r is constant with value unity over the range from 10°K to 100°K and a collision frequency which includes only those collisions for which $r \leq 0.993\sigma$. The temperature dependence of the collision frequency for this model is significantly different than the rate based on a viscosity cross section. Author

N67-36173 Israel Inst. of Tech., Haifa. Dept. of Aeronautical Engineering.
ANALYSIS OF AXISYMMETRIC COMPRESSIBLE ROTATING FREE JETS
A. Chervinsky and D. H. Lorenz [1967] 23 p refs
(TAE-65)

Equations governing the flow of a compressible or heated rotating jet are solved in the von Mises plane, and expressions for the axial and radial distributions of velocity and enthalpy are derived. Relations for the retransformation to the physical plane are obtained and computed for specific initial conditions. Author

N67-36178* Farnham (Frank C.) Co., Philadelphia, Pa.
HYDRODYNAMICS OF THE CRITICAL PHASE [DO HIDRODYNAMIKY KRYTYCHNOYI FAZY]
Yu. P. Krasnyy Washington, NASA, Jul. 1967 9 p refs Transl. into ENGLISH from Ukr. Fiz. Zh. (Kiev), v. 12, no. 1, Jan. 1967 p 122–128
(Contract NASw-1497)
(NASA-TT-F-11103) CSCL 20D

The equations of motion and the boundary conditions for a viscous liquid are derived, taking into account the fact that in the vicinity of the critical point the viscosity coefficients are operators. The slow motion of a liquid in a capillary and the slow motion of a sphere in a liquid are also discussed. It is found that on approaching the critical point the velocity of the liquid in the capillary tends to zero, while the motion of the sphere ceases to obey Stokes' law. Author

N67-36439 Lockheed Missiles and Space Co., Sunnyvale, Calif.
THEORY OF THE MOTION OF A VORTEX RING SUBJECTED TO GRAVITY. ASCENT OF AN ATOMIC CLOUD
A. T. Onufriev [1967] 18 p refs Transl. into ENGLISH from Prikl. Mekh. i Tekhn. Fiz. (USSR), no. 2, 1967 p 3–15

The motion of a vortex ring subjected to gravity is considered. A system of equations governing the motion is derived, taking account of turbulent mixing and adiabatic expansion. The case of the motion of a ring having a density slightly different from the density of the ambient medium is analyzed. A numerical solution of the system of equations is obtained for the case of motion of a ring formed in an explosion in an inhomogeneous atmosphere. A comparison is made with experimental data and other theories existing in the literature. Considered theoretically is the motion of a vortex ring subjected to gravity for cases simulating meteorological phenomena, when the difference between the densities within and outside the cloud is small, and for the case of an explosion when the difference in the densities is great, on the basis of a motion scheme. Author

N67-36445# United Kingdom Atomic Energy Authority, Harwell (England). Atomic Energy Research Establishment.
EXPERIMENTS ON LARGE GAS BUBBLES IN LIQUIDS
R. Collins Feb. 1967 40 p refs
(AERE-R-5402) CFSTI: HC $3.00/MF $0.65

Experiments performed to ascertain the effect of a containing cylindrical boundary on the velocity of a large gas bubble in a liquid were found to agree well with theoretical predictions of velocity expressed in terms of the apparent radius of curvature of the bubble cap. An empirical relation between cap curvature and bubble volume allows the theory to be recast as a semi-empirical theory relating velocity with volume, in which form it agrees with experimental results obtained by previous investigators, but the relation between volume and curvature obtained does not agree with that employed by Uno and Kintner (1956). It is argued that further work would be necessary before the application of the present results to bubbles in fluidized beds can be justified. Tabulated results from both this and previous investigations are given. Author (NSA)

N67-36477# Colorado State Univ., Fort Collins. Fluid Dynamics and Diffusion Lab.
DYNAMIC RESPONSE OF PRESSURE TRANSMISSION LINES TO PULSE INPUT

Arpad Gorove and J. E. Cermak Jun. 1967 104 p refs
(Grant DA-AMC-28-043-65-G20)
(CER66-67AP-JEC51; AD-654455)

The dynamic response of pressure transmission lines to pulse input was investigated experimentally. The most commonly used commercially available flexible Tygon tubings were examined at a constant 1/2-psi air pressure with a frequency up to 300 cps. Short tubings, from 1 inch to 3 feet and inside diameters between .052 inch and 1/4 inch, were tested in the experiment. Pressure transducers were selected which had very small internal volume and the reference transducer was kept at a practical minimum distance from the pressure source. Tubing with and without inlet restriction was investigated to determine the phenomenon of resonant frequency. To determine the effect of the elastic wall of the tubing on the pressure response, comparison measurements were taken in rigid wall, flexible Tygon, and rubber tubings. Phase shift of flexible tubings with various lengths and inside diameters were determined for the frequency range 0.300 cps.
Author (TAB)

N67-36518# Imperial Coll. of Science and Technology, London (England). Dept. of Mechanical Engineering.
A THEORETICAL AND EXPERIMENTAL INVESTIGATION OF DIFFUSION-CONTROLLED ELECTROLYTIC MASS TRANSFER BETWEEN A FALLING LIQUID FILM AND A WALL
A. Iribarne, A. D. Gosman, and D. B. Spalding Dec. 1966 45 p refs
(TWF/R/4)

Measurements have been obtained of the mass-transfer coefficient between a falling liquid film and a vertical surface; the diffusion-controlled electrolytic mass-transfer technique was employed. The measurements are compared with predictions based on an adaptation to film flows of a theory given by one of the present authors for heat or mass transfer through boundary layers. There is good agreement between theory and experiment provided that the film Reynolds number is outside the range of approximately 700 to 1000.
Author

N67-36581 Lockheed Missiles and Space Co., Sunnyvale, Calif.
ON QUALITATIVE SINGULARITIES OF THE FLOW OF A VISCOPLASTIC MEDIUM IN PIPES [O KACHESTVENNYKH OSOBENNOSTIAKH TECHENII VIAZKO-PLASTICHESKOI SREDY V TRUBAKH]
P. P. Mosolov and V. P. Miasnikov [1967] 8 p refs Transl. into ENGLISH from Prikl. Mat. i Mekh. (Moscow), v. 31, no. 3, 1967 p 581–585

An analysis is made of the qualitative singularities of a viscoplastic flow in cylindrical pipes of arbitrary cross section under the effect of a constant pressure drop at the ends of the pipe. The method of qualitative analysis of the motion is used to obtain a global condition for the existence of dead zones, which is connected with the configuration of the pipe cross section, and to refine the location of the dead zones in a number of cases. A more accurate estimate of the size of the flow nuclei is also obtained.
R.N.A.

N67-36650# California Univ., Davis. Crocker Nuclear Lab.
LOWER BOUND TO THE PRESSURE IN ONE-DIMENSIONAL SYSTEMS
Claude Garrod 24 Feb. 1967 12 p
(Contract AT(11-1)-GEN-10)
(UCD-CNL-78) CFSTI: HC $3.00/MF $0.65

Using a minimum principle for the grand potential a lower bound is derived for the pressure of a one-dimensional gas as a function of temperature and chemical potential. Author (NSA)

13 GEOPHYSICS

Includes aeronomy; upper and lower atmosphere studies; oceanography; cartography; and geodesy. For related information see also: 20 Meteorology; 29 Space Radiation; and 30 Space Sciences.

N67-35336* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
EVOLUTION OF THE EARTH'S ATMOSPHERE
S. I. Rasool [1967] 8 p
(NASA-TM-X-60232) CSCL 04A

The diversity in composition in planetary atmospheres is discussed with special attention to composition of the Earth. A comparison of the deficiency factors of rare gases with those of nonvolatiles such as Na, Mg, Al, and Si is tabulated. This suggests that the Earth lost all elements that could have been gaseous at temperatures of a few hundred degrees during the very early history of the planet. For the Earth there is convincing evidence that the present atmosphere and hydrosphere arose largely from the interior by way of volcanic emanations. Theories for the presence of the volatiles now present at the Earth's surface are briefly mentioned. The growth of oxygen in the Earth's atmosphere is explained, and difficulties arising in construction of an evolutionary model of the atmosphere are examined.
S.P.

N67-35396# Smithsonian Astrophysical Observatory, Cambridge, Mass.
GEODETIC PARAMETERS FOR A 1966 SMITHSONIAN INSTITUTION STANDARD EARTH. VOLUME 3: INTERPRETATION OF RESULTS
Charles A. Lundquist and George Veis, ed. 1966 138 p refs
(SAO-Special Rept.-200, Vol. 3) CFSTI: HC $3.00/MF $0.65

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3. THE GEOMETRIC STRUCTURE OF THE EARTH'S GRAVITATIONAL FIELD W. Kohnlein p 21–102 (See N67-35399 21-13)
4. THE ACCURACY OF THE GEOPOTENTIAL AND ITS GRADIENT FIELD W. Kohnlein p 103–114 (See N67-35400 21-13)
5. RELATION WITH DSIF STATIONS G. Veis p 115–126 (See N67-35401 21-13)

N67-35397# Smithsonian Astrophysical Observatory, Cambridge, Mass.
GEODETIC INTERPRETATION
George Veis *In its* Geodetic Parameters for a 1966 Smithsonian Inst. Std. Earth, Vol. 3 1966 p 1–14 (See N67-35396 21-13)

The method of determining datum shifts and the deflection of the vertical for the data by comparing the datum geodetic coordinates with the terrestrial coordinates for the 12 Baker–Nunn stations is described. A correction factor, resulting from a new GM value obtained from recent satellite observations, is used to modify the C5 set of coordinates to the C6 system. Tables of the geodetic and terrestrial coordinates, datum shifts, and deflections of the vertical, for both the C5 and C6 systems are presented. The new universal geodetic datum in the C6 system is discussed, and the astrogeodetic geoidal map is included.
N.E.N.

N67-35398# Smithsonian Astrophysical Observatory, Cambridge, Mass.

COMPARISON WITH SURFACE GRAVITY

W. E. Strange *In its* Geodetic Parameters for a 1966 Smithsonian Inst. Std. Earth. Vol. 3 1966 p 15–20 (See N67-35396 21-13)

The satellite results obtained by Gaposchkin (1966) and the surface gravity data obtained from Uotila (1959) are compared in terms of anomalous gravity with equal weight given to all harmonic coefficients. A direct numerical comparison between surface and satellite data in the limited area where they are available indicated agreement between the data with a mean deviation of ±6 mgal. A qualitative comparison was made to determine the extent to which satellite-derived gravity results are compatible with known relations between surface gravity and other physical parameters. A remarkable agreement was noted, and reasons for the divergence between this result and earlier correlations are discussed. N.E.N.

N67-35399# Smithsonian Astrophysical Observatory, Cambridge, Mass.

THE GEOMETRIC STRUCTURE OF THE EARTH'S GRAVITATIONAL FIELD

W. Koehnlein *In its* Geodetic Parameters for a 1966 Smithsonian Inst. Std. Earth. Vol. 3 1966 p 21–102 (See N67-35396 21-13)

The gravitations field at sea level, as determined from the motion of artificial satellites, is discussed, considering just the field that normally follows from the spherical function but also including a separate computation of the centrifugal potential. Particular concern is given to field characteristics of geodetic interest. This is especially the case for the equipotential surfaces, the deflection of the verticals, and the shape of the latitude and longitude curves. The Gaussian and mean curvatures are computed and can be used for local best-fit geodetic reference surfaces. The gravity anomalies are of interest in physical geodesy, while the direction of the gradient field gives some picture of the curvature of the gradient lines, and is explicitly computed for the zonal part of the gravitational field. The reference surface used is an ellipsoid of revolution that has the advantage of computational simplicity, and the zonal part of the gravitational field is considered separately. Whenever it is suitable the International Ellipsoid is used for reference in order to simplify the comparison of the new satellite results with the classical methods. Author

N67-35400# Smithsonian Astrophysical Observatory, Cambridge, Mass.

THE ACCURACY OF THE GEOPOTENTIAL AND ITS GRADIENT FIELD

W. Koehnlein *In its* Geodetic Parameters for a 1966 Smithsonian Inst. Std. Earth. Vol. 3 1966 p 103–114 (See N67-35396 21-13)

A numerical analysis of the accuracy in applying a least squares method is presented. A normal error distribution is assumed, and a method of normalizing the results is given. Tables are included of the normalized standard deviations for zonal parts, nonzonal parts, and combinations of zonal and nonzonal parts. N.E.N.

N67-35401# Smithsonian Astrophysical Observatory, Cambridge, Mass.

RELATION WITH DSIF STATIONS

George Veis *In its* Geodetic Parameters for a 1966 Smithsonian Inst. Std. Earth. Vol. 3 1966 p 115–126 (See N67-35396 21-13)

The positions of three Deep Space Instrumentation Facilities are compared with the positions of three Baker–Nunn stations. The DSIF stations are located in Goldstone, California; Johannesburg, South Africa; and Woomera, Australia. The two Baker–Nunn stations of Woomera and Olifantsfontein are close to two of the DSIF stations, and the Organ Pass station is within 1000 km of Gladstone. Each pair of stations is connected by triangulation, and their relative positions are expressed in terms of differences of their Cartesian geodetic coordinates. It is concluded that the results of the two completely different systems agree within their stated uncertainty, and that the agreement increases the reliability of both techniques. N.E.N.

N67-35407# Defence Research Board, Ottawa (Ontario).

CHARACTER OF THE MAGNETIZATION OF THE PERMIAN DEPOSITS IN THE VIATKA RIVER BASIN

G. M. Avchian and S. S. Faustov May 1967 9 p refs Transl. into ENGLISH from the book "Nastoyashchaye i Proshloye Magnitnogo Polia Zemli" Moscow, Nauka Press, 1965 p 245–250 (T-479-R; TT-67-62204; AD-654481)

The paleomagnetic character of the Upper Permian section of the Viatka River Basin was studied in the rocks. In the resulting stereographic projections the directions of natural remanent magnetization may be tentatively divided into three groups. (1) In vectors with directions clustering around the present-day magnetic pole. This clustering indicates rocks that are unstable as regards their paleomagnetism. (2) In vectors lying in the declination range 200 degrees to 230 degrees and inclination range -40 degrees to -10 degrees. (3) In vectors occupying a region elongated in the southwest direction in such a way as to bridge the gap between Groups 1 and 2. The inclination of the In vectors varies from -20 to +70 degrees and declination from 200 degrees to 360 degrees. To separate these magnetizations and to reveal their quantitative characteristics, a vector analysis of the measurement data was made. Author (TAB)

N67-35411# Defence Research Board, Ottawa (Ontario).

RESULTS OF PALEOMAGNETIC STUDY OF TRIASSIC FORMATIONS IN THE CENTRAL URALS

N. P. Karmanova May 1967 6 p refs Transl. into ENGLISH from the book "Nastoyashcheye i Proshloye Magnitnogo Polia Zemli" Moscow, Nauka Press, 1965 p 250–253 (T-480-R; TT-67-62205; AD-654482)

The study of the rocks in question was carried out by the Experimental Methods Group of the Urals Geological Directorate, using samples from Central Transuralia collected on the banks of the Sinara, Pyshma, Bobrovka and Bichur Rivers. The magnetic susceptibility of the basalts varies in the mean from 500 to 3000.0.000001 CGSM. Attention was given to studying the magnetic stability of the rocks and to the methods of magnetic cleaning. The remanent magnetization of many Uralian rocks showed itself to be a viscous magnetism. Only basalts, porphyrites of basaltic composition, diabases, orthophyres and red argillites were found to be magnetically stable. But even in these rocks, particularly when taken from natural outcrops, we often find samples partially or entirely remagnetized. Consequently for paleomagnetic research in the Urals a particular importance attaches to methods of magnetic cleaning, which permit the primary remanent magnetization to be separated out. Author (TAB)

N67-35435# Defence Research Board, Ottawa (Ontario).

PALEOMAGNETIC STUDY OF SOME UPPER CRETACEOUS SECTIONS IN THE WESTERN FOOTHILLS OF THE FERGHANA RANGE

A. N. Shemleva May 1967 12 p refs Transl. into ENGLISH of the Publ. "Paleomagnitnyye Stratigraficheskiye Issledovaniya" Leningrad, Gostoptekhizdat, Issue no. 204, 1963 p 212–219 (T-477-R; TT-67-62202; AD-654479)

The paleomagnetic study of the Cretaceous deposits, was based on the two most complete and best exposed sections, along the Kara-Kuldzha River and on the slopes of Mount Kampyr-Rovat. The 234 selected samples are distributed as follows. For 222 out of the 234 samples the direction of natural remanent magnetization was determined with adequate reliability. The Cenomanian is represented in the sections by a large bed of

orange-red sandstones with interlayers of red clays and aleurolites, which in the Kara-Kuldzha region has a total thickness of 400 m and mean bed position azimuth 250 degrees dip 48 degrees; the natural remanent magnetization of the sampled rocks varies within the range. Author (TAB)

N67-35436# Aeronautical Chart and Information Center, St. Louis, Mo. Linguistic Section.
ORGANIZATION AND PLANNING OF GEODETIC AND TOPOGRAPHIC OPERATIONS
V. F. Pavlov, ed. Mar. 1967 275 p refs Transl. into ENGLISH of the book "Organizatsiya i Planirovaniye Geodezicheskikh i Topograficheskikh Rabot" Moscow, Nedra, 1965 p 1–299
(ACIC-TC-1144; TT-67-62249; AD-654663)

The subject of this translation is the organization and planning of production, economic and financial activities of enterprizes which carry out geodetic and topographic operations in the U.S.S.R. The study is to help U.S.S.R. specialists become all-around educated engineers, who keep in mind that any technical question should be coordinated with economic expediency. Author (TAB)

N67-35454# California Univ., Livermore. Lawrence Radiation Lab.
THEORETICAL AMPLITUDES AND TRAVEL TIMES OF EXPLOSION-GENERATED SEISMIC P WAVES
John Roberts 5 Apr. 1967 10 p refs
(Contract W-7405-ENG-48)
(UCRL-50232) CFSTI: HC $3.00/MF $0.65

Amplitudes and travel times have been calculated for the first half-cycle of seismic P waves generated by nuclear explosions at distances varying from 140 to 2900 km. The head-wave–body-wave model constructed yields travel times within ±3.9 sec of the mean experimental values over the indicated range of distances and also provides an interpretation of the large–small–large nature of the amplitudes. Author (NSA)

N67-35469# Air Force Cambridge Research Labs., Bedford, Mass. Upper Atmosphere Physics Lab.
A THEORY OF THE AURORAL AFTERGLOW OF NITROGEN
O. Oldenberg Apr. 1967 26 p refs *Its* Phys. Sci. Res. Papers, No. 323
(AFCRL-67-0252; AD-654300)

An attempt is made to explain the auroral afterglow or short-duration afterglow of nitrogen, discovered in 1932 by Kaplan, in terms of well established processes. In this afterglow, N2+ bands are excited together with bands of neutral N2 molecules, which show energies far exceeding the limit evident in the well known long-duration afterglow (Lewis-Rayleigh afterglow). This limit is given by the energy of recombining N atoms, 9.76 eV. Author (TAB)

N67-35480# Air Force Cambridge Research Labs., Bedford, Mass. Meteorology Lab.
MESOSCALE STRUCTURE OF THE ATMOSPHERE IN REGIONS OF CLEAR-AIR TURBULENCE, VOLUME I
Samuel Penn and Thomas A. Pisinski Apr. 1967 96 p refs *Its* Surv. in Geophys. No. 190
(AFCRL-67-0115; AD-654267)

The mesoscale structure of the atmosphere in regions of Clear-Air Turbulence (CAT) is investigated by means of aircraft observations of wind, temperature, and ozone obtained in the upper troposphere and in the lower stratosphere. Analysis from five CAT missions are shown, including vertical cross sections normal to flow patterns and also detailed vertical soundings of wind, temperature, and the Richardson number. A verification is obtained at intervals of 1000 ft between the occurrence of CAT and a Richardson criterion of 0.5. Over 70 percent of the 149 CAT cases are correctly specified by the criterion. Author (TAB)

N67-35531# Atomic Energy Commission, Washington, D. C. Technical Information Div.
THE ATOM AND THE OCEAN
E. W. Seabrook Hull Jul. 1967 66 p
Available from AEC, Oak Ridge, Tenn.

Oceanographic nuclear instrumentation for obtaining information about ocean minerals, currents, and sea life are described. Also discussed are means of obtaining fresh water from seawater by nuclear desalinization plants; the radiation preservation of seafood, obtaining of radionuclides from the sea; ocean engineering studies; and Project Plowshare. A list of suggested reference books, booklets, articles, and motion pictures concerning the uses of atomic energy in ocean studies, is given. L.S.

N67-35567# Johns Hopkins Univ., Baltimore, Md. Dept. of Mechanics.
SOURCES AND SINKS ON A β-EARTH
Robert R. Long Jul. 1967 26 p refs
(Contract Nonr-4010(01); Grant E-9-67(G))
(TR-23; TR-26; AD-655141)

This paper is concerned with flow on a beta-earth toward a sink. A perfect-fluid solution for a strong sink at the equator midway between two rigid latitude circles shows that the streamline that divides flow from the west and flow from the east is a straight, north-south line through the sink when the beta-effect is neglected, but tilts toward the west when it is taken into account. The beta-effect also causes the sink to draw more strongly from its own latitude in the region west of the sink and less strongly from its own latitude east of the sink. This agrees with qualitative reasoning based on the vorticity equations. Solutions are also found for a weak, viscous sink at an arbitrary latitude. Approximate analytical expressions, valid far from the origin, indicate greatly different flow patterns in the western and eastern sectors. In the former the motion is divided into two components. One is a jet at the latitude of the sink, and this jet carries the entire flux into the sink. The other corresponds to motion induced by the basic rotation itself and is a flattened portion of a vortex in the same region occupied by the westerly jet. The jet component dominates at sufficiently great distances. The flow from the east dies off exponentially with distance and has a wave-like character. Author (TAB)

N67-35597# Avco Corp., Wilmington, Mass. Space Systems Div.
ACOUSTIC GRAVITY WAVE STUDY Interim Technical Report
David G. Detert, Charles A. Moo, Allan L. Oster, and Warren E. Woolhiser Griffiss AFB, N. Y., RADC, May 1967 108 p
(Contract F30602-67C-0016)
(RADC-TR-67-101; AD-654696)

The report describes the efforts of the first four months of a one-year contract to study the propagation of acoustic gravity waves in the lower atmosphere and ionosphere, considering in particular the static firing of rocket engines and the occurrence of local thunderclouds as possible sources of such energy. The status of the program is outlined, theoretical and experimental concepts are discussed, and details of the equipment developed for the program are presented. Author (TAB)

N67-35612# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.
DETERMINATION OF THE ASPHERICITY PARAMETERS OF THE EARTH'S ATMOSPHERE FROM CHANGES IN THE ORBITAL ELEMENTS OF ARTIFICIAL SATELLITES
A. M. Fominov 28 Apr. 1967 51 p refs Transl. into ENGLISH from Byul. Inst. Teor. Astron. (USSR), vol. 9, no. 7, 1964 p 499–521
(Contract NOw-62-0604-c)
(TG-230-T519; TT-67-62239; AD-654562)

An equation is set up for the air density distribution in the earths atmosphere on the basis of change in the orbital period of satellites. The parameters characterizing the latitude, diurnal, and solar activity effects in the air density distribution were obtained from data on orbital periods and elements of 1958 Alpha, 1960 Xi 1, 1961 NU 1, and 1959 Eta. Determination of the latitude effect from observed changes in orbital period is uncertain, and must be allowed for theoretically. The amplitude of the diurnal effect increases with geocentric distance, whereas solar activity seems to be weakly dependent on the altitude. Author (TAB)

N67-35620# Air Force Cambridge Research Labs., Bedford, Mass. Upper Atmosphere Physics Lab.
OBSERVATIONS ON THE RELEASE OF A CLOUD OF BARIUM ATOMS AND IONS IN THE UPPER ATMOSPHERE
Keith H. Lloyd and Dan Golomb Apr. 1967 41 p refs *Its* Environ. Res. Paper No. 268
(AFCRL-67-0144; AD-654687)

The paper presents the results of observations on a series of releases of barium neutral atoms and ions in the upper atmosphere. One release, at 195 km, is discussed in detail. Because of the effect of winds and the earths magnetic field on the ionized cloud, the neutral and ionized clouds drifted apart. The diffusion and descent of the neutral cloud allowed estimates of the atmospheric density and scale height to be made; the ratio of the ambipolar diffusion to the neutral diffusion coefficient of the ionized cloud yields the temperature of the atmospheric electrons. These values agree very well with the COSPAR International Reference Atmosphere. The observed drift and descent of the ionized cloud can be explained satisfactorily only if there is an electric field in the atmosphere of 1.1 x 10-3 volts m-1. The ambipolar diffusion perpendicular to the earths magnetic field was much faster than predicted from molecular diffusion theory, and could be due to a Bohm diffusion caused by plasma instabilities. Author (TAB)

N67-35621# Innsbruck Univ. (Austria).
THE FREQUENCY DEPENDENCE OF THE DIELECTRIC CONSTANT AND CONDUCTIVITY OF ROCK AND ITS RELATION TO QUANTITIES OF ROCK FABRIC Scientific Report, 1 Mar. 1966–31 Mar. 1967
Hans Wobking 25 Apr. 1967 37 p refs
(Contract AF 61(052)-902)
(AFCRL-67-0362; SR-3; AD-654733)

The measured frequency dependence of the dielectric constants and conductivities of water-containing rocks is explained qualitatively and partly also quantitatively, by means of interfacial polarization and by a theoretical consideration on dielectric losses. The relations between the relaxation times of the rock - water system and water content obtained by experiment, and the relations between conductivity and water content of the examined rock samples are given. Furthermore, the dependence of the electrical parameters on the rock fabric is shown and a method is described for measuring by an electrical process, the water content and porosity of a low-porous rock sample. Author (TAB)

N67-35685# Kakioka Magnetic Observatory (Japan).
GEOELECTRIC OBSERVATIONS AT KAKIOKA, JAPAN IN 1959
1967 88 p refs
(Rept.-47)

Tabular data for geoelectric observations of several elements were carried out at the Kakioka Magnetic Observatory in Japan, for the year 1959. The geographic and geomagnetic coordinates of the Observatory are listed by latitude and longitude. The instrument for measurement of atmospheric electric potential gradient was a Benndorf's self-recording electrometer. A water-dropper and a radioactive collector were used for the set of high sensitivity and also for the low sensitivity. Results of geoelectric observations are presented for atmospheric electricity, atmospheric electric potential gradient, atmospheric electric conductivity, and earth-current potential gradient. R.U.

N67-35686# Kakioka Magnetic Observatory (Japan).
GEOMAGNETIC OBSERVATIONS AT KANOYA, JAPAN IN 1958–1959
1967 115 p refs
(Rept.-45)

Geoelectric observations are tabulated for geomagnetic data by the Kakioka Magnetic Observatory, one of the two branch magnetic observatories, located in Kanoya City, Kyushu, Japan. The geographic and geomagnetic coordinates of the Observatory are listed by latitude and longitude. Magnetic observations are tabulated according to variometers, scale values, base-line values, hourly values and associated mean values, and principal magnetic disturbances. R.U.

N67-35687# Kakioka Magnetic Observatory (Japan).
GEOMAGNETIC OBSERVATIONS AT KAKIOKA, JAPAN IN 1948–1949
1967 127 p refs
(Rept.-39)

This one-of-a-series report presents the results of geomagnetic observations carried out by the Kakioka Magnetic Observatory, in Japan, during 1948 and 1949. Magnetograms for days of remarkable magnetic disturbances are reproduced, and tabular data depict hourly values and associated mean values. R.U.

N67-35688# Kakioka Magnetic Observatory (Japan).
GEOMAGNETIC OBSERVATIONS AT KAKIOKA, JAPAN IN 1950–1951
1967 118 p refs
(Rept.-40)

Geomagnetic observations carried out by the Kakioka Magnetic Observatory, Japan, during 1950 and 1951 are reported. Hourly values and associated mean values are tabulated, and magnetograms depict days of remarkable magnetic disturbances. R.U.

N67-35711*# Texas A&M Univ., College Station. Dept. of Oceanography.
THE SPACE OCEANOGRAPHY PROJECT Status Report, 1 Mar.–1 Jun. 1967
Luis R. A. Capurro and Dale F. Leipper 1 Jun. 1967 17 p refs Sponsored in part by NASA
(Contract Nonr-2119(04))
(NASA-CR-88102; AD-654411) CSCL 08J

Most of the investigations programmed in the project depend on the information obtained from the flights made with the research aircraft NASA 926 Convair 240 which was the only one instrumented and in operation. Unfortunately, the output of data from the flight missions was very limited. From the total of five flight missions scheduled for the program; July, October and December 1966, February and April 1967; only two can be considered successful: July 1966 and February 1967. Project staffing, facilities and capabilities as well as projected research plans for the forthcoming quarter are outlined together with a consideration of arrangements whereby the utilization of remote sensors for oceanographic studies may be made effective. Author (TAB)

N67-35725# Lincoln Lab., Mass. Inst. of Tech., Lexington.
SIGNAL AND NOISE RESPONSIVENESS AT LASA
D. E. Frankowski 12 Apr. 1967 164 p
(Contract AF 19(628)-5167)
(ESD-TR-67-24; LL-5; AD-655109)

Signal and noise responsiveness at LASA are presented. Signal responsiveness is given as peak-to-peak measurements. Noise responsiveness is given as spectral estimates in various frequency bands. Author (TAB)

N67-35745# Westinghouse Research Labs., Pittsburgh, Pa.
STUDIES AND EXPERIMENTAL WORK ON ATOMIC COLLISION PROCESSES OCCURRING IN ATMOSPHERIC GASES Technical Report, 22 Dec. 1965–1 Sep. 1966
A. V. Phelps and W. H. Kasner Kirtland AFB, N. Mex., AF Weapons Lab., Jun. 1967 52 p refs
(Contract AF 29(601)-6729)
(RR-66-6E2-GASES-R4; AFWL-TR-66-121; AD-654657) CFSTI: HC $3.00/MF $0.65

Microwave and mass spectrometric techniques have been used to study electron-ion recombination in the afterglow of 'single pulse' microwave discharges under conditions where $O_2(+)$ is the only significant afterglow ion species. At room temperature (approximately equals 300 K) the measured recombination coefficient, alpha ($O_2(+)$), has a value of (2.2 plus or minus 0.4) × 0.0000001 cu cm/sec. A significant temperature dependence for alpha ($O_2(+)$) has been observed. The values ranging from approximately 3.6 × 0.0000001 cu cm/sec at 200 K to 1.8×0.0000001 cu cm/sec at 550 K. Several associative detachment reactions involving the negative ion $O(-)$ have been studied. The measured reaction rates are all in excess of 10 to the minus 10th power cu cm/sec. In particular, a preliminary value of 4 × 10 to the minus 10th power cu cm/sec has been obtained for the $O(-) + O$ associative detachment reaction. The apparent destruction of $O_2(-)$ by O has also been observed, but no reliable quantitative results are available at this time. The energy dependence of some of these reactions have been studied over the range 0.042 to 0.10 EV. Author (TAB)

N67-35749# Boeing Scientific Research Labs., Seattle, Wash. Geo-Astrophysics Lab.
IPDP EVENTS AND THEIR GENERATION IN THE MAGNETOSPHERE
H. B. Knaflich and J. F. Kenney May 1967 22 p refs
(D1-82-0616; AD-654974)

Irregular pulsations of decreasing period are characterized by a broad band of ULF noise that rises in frequency over the duration of the event. IPDP events frequently have structured elements in the noise that have been detected simultaneously at conjugate stations by Gendrin and Troitskaya. Under the assumption that these structured elements have been generated at the equator in the magnetosphere by an impulsive source, the later arrival of the higher frequencies may be interpreted as the results of propagation in a dispersive medium. Methods that have been applied to pc 1 events are applied to the structured elements of IPDP events to locate their origin in the magnetosphere. The dispersion analysis of the structured IPDP elements observed during 1965 and 1966 shows that they are generated in a narrow range of solar magnetospheric longitude centered around 20 hours local time at L values between 6 and 13 earth radii. The broad-band unstructured noise seems to originate in a zone of magnetic turbulence just outside the normal trapping region, so that the structured elements could be the dispersed signal resulting from a broad-band impulse. This could also be evidence for particle injection into the magnetosphere during times of elevated magnetic activity. Author (TAB)

N67-35763# Air Force Cambridge Research Labs., Bedford, Mass. Upper Atmosphere Physics Labs.
MEASUREMENTS OF TIDAL OSCILLATIONS ABOVE 120 KILOMETERS Interim Scientific Report
S. P. Zimmerman and F. A. Marcos Apr. 1967 18 p refs *Its* Environ. Res. Papers No. 266
(AFCRL-67-0131; AD-654686)

Studies of the altitude variations of upper atmospheric winds indicate oscillatory components of the horizontal wind motion in the vertical plane. The smaller scales of these oscillatory motions have been shown to be the lengths predicted by the theory of the viscous limited internal gravity waves. Measurements of the large scales in the 120 to 180 km altitude range have shown a marked correlation to the pressure scale height. Analysis of these large-scale vertical wavelengths indicates that the equivalent depth (h) of the atmosphere corresponds to two of the eigenmodes of earths atmosphere or model atmosphere of the solar semidiurnal tide predicted by the Laplace tidal equation. These are, respectively, the (2, 4) mode which appears to dominate in the summer, and the (2, 6) mode which is dominant in the winter. Author (TAB)

N67-35777*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
TEMPERATURE, PRESSURE, DENSITY AND WIND MEASUREMENTS IN THE UPPER STRATOSPHERE AND MESOSPHERE, 1965
W. S. Smith, J. S. Theon, P. C. Swartz, L. B. Katchen, and J. J. Horvath (Mich. Univ., Ann Arbor) Washington, NASA, Sep. 1967 95 p refs
(NASA-TR-R-263) CFSTI: HC $3.00/MF $0.65 CSCL 04A

Complete data are presented from a total of 43 rocket borne experiments conducted at Wallops Island, Virginia, Churchill, Manitoba, Canada, Barrow, Alaska, Ascension Island in the South Atlantic Ocean and from a ship sailing southward from the equator to 60°S latitude off the west coast of South America during 1965. Temperature, pressure, density and wind profiles from 33 grenade experiments and temperature, pressure and density profiles from 10 pitot-static tube experiments covering the altitude range of approximately 30 to 90 kilometers have been compiled. No attempt has been made to analyze the meteorological significance of these data in this report. Error analyses are included for the results of each of the 33 grenade experiments. Author

N67-35834# White Sands Missile Range, N. Mex. Atmospheric Sciences Lab.
DIURNAL VARIATION OF OZONE AT HIGH ALTITUDES
Jagir S. Randhawa May 1967 24 p refs
(ECOM-5124; AD-654994)

A rocket-borne ozonesonde (self-pumping type) has been developed which uses the chemiluminescent principle for the detection of ozone concentration in the atmosphere. This has been flown with the Arcas rocket at Fort Greely, Alaska, during the day as well as at night. The results show large diurnal variations in upper stratospheric ozone and agree with the observations made at White Sands Missile Range with different rocket-borne ozonesondes (sampling chamber). Results of sounding made at White Sands Missile Range with the self-pumping type instrument are also presented. Ozone concentrations found with these rocket-borne ozonesondes show higher values of ozone in the upper stratosphere than that predicted by oxygen photochemical theory. Author (TAB)

N67-35841# Columbia Univ., Palisades, N. Y. Lamont Geological Observatory.
OPERATION OF A LONG PERIOD SEISMOGRAPH NETWORK UTILIZING MAGNETIC TAPE RECORDING AND ANALYSIS OF DATA RECORDED ON MAGNETIC TAPE Annual Report, 1 Jun. 1965–31 May 1966
Paul W. Pomeroy 31 May 1967 7 p
(Contract AF 19(628)-5058; ARPA Order 292)
(AR-1; AD-654298)

The paper contains a network of seismological stations, their major scientific work using a magnetic tape recording and analysis of data on seismic waves, earthquakes, underground nuclear explosions, wave transmission, and mathematical analysis of the results in the system. Author (TAB)

N67-35880# National Aeronautics and Space Inst., Bandung (Indonesia).
MODIFICATIONS OF ION-DENSITIES DUE TO TEMPERATURE VARIATIONS

Ruby Lonan Kusumanto 1967 2 p refs Presented at the IOSY–COSPAR Symp., London, Jul. 1967
(Rept.-5) CFSTI: HC $3.00/MF $0.65

Results of modifications of ion-density-data are reported. These modifications result from two different reference atmospheres, being made use of and carried out by a differential formula. It was concluded that observations of ion-densities should indeed be paired by observations on electron-densities and normalization is necessary. Author

N67-35894# California Univ., San Diego. Applied Oceanography Group.
A SYSTEM FOR AIRBORNE MEASUREMENTS OF THE TOTAL HEAT FLOW FROM THE SEA SURFACE
Edward D. McAlister 30 Jun. 1967 57 p refs
(Contracts Nonr-2216(13); Nonr-2216(05); Grant NSF G-854)
(U-636; AD-654916)

Solar energy (10 to the 21st power calories) is stored during one average day in the top 30 meters of the worlds oceans. Its release during a 24 hour cycle depends on wind speed, cloud cover, air temperature and other factors. Where it is released, geographically, the amount and time of release and its transport to other parts of the globe are factors which determine climate (the average condition) and weather (variations from the average). It is thus important to have means of measuring this heat flow from the oceans in order to better understand weather and its long range prediction. The paper reports progress on the development of airborne equipment which for the first time provides direct measurement of this heat flow. The results reported herein establish the feasibility of an infrared optical method. The equipment in its present form can survey 10,000 square miles of sea surface in a 24 hour period. It is possible that similar equipment may be developed for satellite use, but this remains to be demonstrated. Author (TAB)

N67-35911*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
NEUTRAL AIR WAVES IN THE THERMOSPHERE
H. Volland Aug. 1967 46 p refs
(NASA-TM-X-55901; X-621-67-370) CFSTI: HC $3.00/MF $0.65
CSCL 04A

Under the influence of gravity, heat conduction, molecular viscosity, Coriolis force and ion drag eight plane characteristic waves obliquely incident on a horizontally stratified atmosphere can propagate, four of them upward and the other four downward. The four pairs of characteristic waves are the well known acoustic-gravity waves, heat conduction waves, and the ordinary and extraordinary viscosity waves. The eigenvalues of the characteristic waves are calculated numerically giving the following main results: (a) Under the influence of heat conduction acoustic-gravity waves exist in the whole frequency range and at all angles of incidence. (b) Coriolis force and ion drag make the atmosphere anisotropic with respect to the characteristic waves. Their propagation characteristics at east-to-west and at north-to-south propagation differ from each other. (c) At the equator upgoing internal gravity waves prefer a predominant west to east path while downgoing heat conduction waves tend to propagate from north to south. (d) Downgoing internal gravity waves travelling from north to south lose their abnormal behavior under the influence of the Coriolis force and have phase and group velocities the vertical component of which go in the same direction. Author

N67-35919# White Sands Missile Range, N. Mex. Atmospheric Sciences Lab.
SPACIAL AND TEMPORAL DISTRIBUTION OF THE GRADIENT RICHARDSON NUMBER IN THE SURFACE AND PLANETARY LAYERS
Frank V. Hansen May 1967 30 p refs
(ECOM-5123; AD-654993)

The Richardson number (Ri) as a function of height, time and stability classification method has been investigated by the use of wind and temperature profiles observed in the surface and planetary boundary layers. It was found that a reference height of three to six meters above the surface provides the best estimate of the Richardson number in respect to the energy balance of the air-earth interface. Further investigation revealed that nearly all boundary layer processes can be related to the Richardson number including a hypothesis in the form of wind and temperature profiles for a diabatic surface boundary layer. Author (TAB)

N67-35928# Air Force Systems Command, Wright-Patterson AFB, Ohio. Air Force Materials Lab.
FORCES INVOLVED IN THE AXISYMMETRIC EXTRUSION OF METALS THROUGH CONICAL DIES Technical Report, Feb. 1964–Dec. 1966
Cyril Marvin Pierce May 1967 102 p refs
(AFML-TR-67-83; AD-654649)

Numerous billets of AISI 1018 steel at 1800 F and OFHC copper at 800 F were direct extruded on a 700-ton horizontal press in order to determine the effects of such process variables as reduction ratio, billet length, lubrication condition, and die angle on the forces involved in the operation. A unique measurement system was employed which quantitatively determined the deformation force of the die as well as the total required extrusion force on the stem. Author (TAB)

N67-35933 Atomic Energy Centre, Lahore (Pakistan). Chemistry Div.
APPLICATION OF GAMMA RADIATION FOR THE DETERMINATION OF BED LOAD IN FLUVIAL CHANNELS
M. A. Lodhi Jan. 1967 11 p refs
(PAEC/CHEM/MISCELL-2)

Methods have been suggested by means of which bed load in hydraulic channels can be determined by the use of gamma emitting sources. These methods differ from the usual tracer techniques in the sense that a radioactive source is buried in the bed and the changes in the response of a suitably placed detector will be a function of the thickness or mass of the sand moving along the bed. Author

N67-35946# Kakioka Magnetic Observatory (Japan).
GEOMAGNETIC OBSERVATIONS AT MEMAMBETSU, JAPAN IN 1952–1959
1967 191 p refs
(Rept.-43)

Tables show the daily mean values of magnetic elements for 1952 through 1956, the hourly values and associated mean values for 1957 through 1959, and geomagnetic activity and principal magnetic disturbances for 1956 through 1959. Magnetograms are reproduced for days of remarkable magnetic disturbance, 1957 through 1959. M.G.J.

N67-35962# Smithsonian Astrophysical Observatory, Cambridge, Mass.
GEODETIC PARAMETERS FOR A 1966 SMITHSONIAN INSTITUTION STANDARD EARTH, VOLUME I
Charles A. Lundquist, ed. and George Veis, ed. 1966 240 p refs
(SAO Special Rept.-200, Vol. 1)

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5. THE ORBITAL METHOD G. Veis p 185–190 refs (See N67-35967 21-30)

6. DETERMINATION OF ZONAL HARMONIC COEFFICIENTS Y. Kozai p 191–194 refs (See N67-35968 21-07)

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8. COMBINATION OF GEOMETRIC AND DYNAMIC METHODS W. Koehnlein p 207–221 refs (See N67-35970 21-07)

N67-35963# Smithsonian Astrophysical Observatory, Cambridge, Mass.

THE REFERENCE SYSTEM

George Veis *In its* Geodetic Parameters for a 1966 Smithsonian Inst. Std. Earth, Vol. 1 1966 p 9–42 ref (See N67-35962 21-13)

To define geodetic parameters it is necessary to define a geodetic reference system in which the geodetic coordinates apply. The three major coordinate systems used in this geodetic reference analysis are a terrestrial system, a celestial system, and an orbital system. As an intermediate system to convert from the celestial system to the terrestrial, the sidereal system is used. Polar motion and the earth's rotation are also considered in this evaluation. R.Ll.

N67-35973# Technische Hochschule München (West Germany). Fakultaet fuer das Bauwesen.

CONCERNING THE PROGRESSION OF CHANGES IN STREAM WATER LEVEL ELEVATIONS WITH CONSTANT MAXIMUM PERMISSABLE WATER LEVEL IN THE RESERVOIR [UEBER DAS FORTSCHREITEN VON ZUFLUSSAENDERUNGEN IN FLUSSTAUHALTUNGEN MIT KONSTANTEM STAUZIEL]

Herwig Stoecki (Ph.D. Thesis) 1966 110 p refs In GERMAN

The relationship between the maximal permissible water level in the reservoir, inflow velocity, and retention behavior with occasional overflow was studied for a river-run power plant. Experiments showed that the inflow changed with the wave flow velocity; a rapid increase or decrease in water flow disturbed the required constant water level and thus effected power plant efficiency. It was concluded that phase flow regulation by hydraulic pumps—either for inflow or outflow—is necessary to keep the water level correct. Transl. by G.G.

N67-35978# Lightning and Transients Research Inst., Minneapolis, Minn.

EXPERIMENTAL TRIGGERING OF NATURAL LIGHTNING

J. R. Stahmann Mar. 1966 65 p ref

(Contract FA-65-WA-1277)

(FAA-ADS-72; AD-654886)

Natural lightning was triggered by directing rockets, trailing thin stainless steel wire, from the Research Vessel Thunderbolt toward charged clouds. One objective was to attempt to trigger the strokes through an F-100 jet flying over the ship. The F-100 carried many recording instruments to measure the effects and characteristics of both direct and nearby lightning strokes. Measurement equipment was also provided on the ship to obtain coordinated stroke characteristics at the sea level stroke termination point. These data are important for lightning protection of aircraft studies, particularly around fuel vent areas. Data concerning current waveform, blast pressure waves and plasma extent were obtained. It was shown that strokes can be triggered about 50% of the time in medium to high electric fields. The lightning hazards to the F-100 were considered and protective measures were devised for the fuel vent and canopy areas. These measures and the aircraft instrumentation were checked with simulated lightning by bringing the aircraft and Thunderbolt together at the Mayport Naval Air Station, Florida. The discharge currents triggered were below the very intense strokes desired and fair weather during the operational period limited results. Since questions concerning blast pressures, plasma extent and other properties of severe lightning remain unresolved, it is important to continue the program in a region where storms with severe strokes may be intercepted with high frequency. Such a location may be found near or north of Tampa on the west coast of Florida. Author (TAB)

N67-35984*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

THE STATISTICAL MEASUREMENT OF SPECTRAL AMPLITUDES AND PHASES OF ATMOSPHERICS IN THE VLF RANGE

H. Volland, G. Heydt (Heinrich-Hertz Inst.) and W. Harth (Bonn Univ.) Aug. 1967 29 p refs Presented at the 13th Symp. of the AGARD Electromagnetic Wave Propagation Comm. on "Phase and Freq. Instability in Electromagnetic Wave Propagation", Ankara, 9–12 Oct. 1967

(NASA-TM-X-55903; X-621-67-422) CSCL 04A

Equipment has been developed which within the VLF range allows the measurement of the statistical spectral amplitude distribution, the ratio of the spectral amplitude at two different frequencies and the statistical group time delay of the phase of the spectral amplitude of atmospherics coming from discrete thunderstorms. The group time delay is directly related to the phase of the propagation function within the atmospheric waveguide and depends on distance, azimuth, frequency, and effective height of the of the waveguide. Its variations with frequency and time have been measured for different thunderstorms. They give evidence of the time change of the ionospheric reflection characteristics within the VLF range. Since the registrations depend on the azimuth of the incoming atmospherics, thunderstorms can be located from the group time-delay measurements. Moreover, the statistical treatment of the atmospherics allows a quantitative determination of the number of lightning flashes within the thunderstorm. Author

N67-36002# Grumman Aircraft Engineering Corp., Bethpage, N. Y. Research Dept.

AN INVESTIGATION OF THE RELATIONSHIP BETWEEN POLARIZATION AND SURFACE STRUCTURE OF RHYOLYTIC PUMICE

Walter G. Egan and Edward A. Nowatzki Aug. 1967 12 p refs Presented at the 48th Ann. Meeting of the Am. Geophys. Union, Washington, D. C., 17–20 Apr. 1967

(RM-370J) CFSTI: HC $3.00/MF $0.65

A polarimetric study of California Mono-Crater region rhyolytic pumice was initiated to determine the effect of surface structure on the polarimetry of intact vesicular material. The program utilized a large scale polarimeter, with initial investigations in the G(0.54μ) spectral region. Samples were cut along the flow strata to produce a surface uniformity. Surface data obtained photographically were reduced by a digitizer. The results, in the form of percent polarization versus phase angle at a 60-degree viewing angle, are compared to a nominal surface slope distribution as a function of angular displacement from the horizontal. Samples are compared to evaluate the effect of surface orientation as well as to determine gross surface effects. The data imply that the percent polarization at a 90-degree phase angle is related to the relative proportion of horizontal to vertical slope lengths. Author

N67-36052 National Physical Lab., New Delhi (India). Radio Propagation Unit.

IONOSPHERE PREDICTIONS FOR AUGUST 1967

May 1967 4 p Prepared for Radio Res. Comm. CSIR

(RRC-B131)

Predictions of ionospheric conditions for August 1967, compiled in India, are depicted graphically. Median foF_2 and MUF-4000-F_2 values are given for north and south latitudes. A monogram is presented for transforming F_2-zero-MUF and

F_2-4000-MUF to equivalent maximum usable frequencies at intermediate transmission distances. A conversion scale to obtain optimum traffic frequencies is included. E.C.

N67-36053# Naval Ordnance Lab., White Oak, Md. Air/Ground Explosions Div.
SHOCK PROPAGATION IN NONHOMOGENEOUS ATMOSPHERES AND MODIFIED SACHS SCALING. PART I: EXPONENTIAL IDEAL-GAS ATMOSPHERE
Morton Lutzky and Delbert L. Lehto 19 Jun. 1967 21 p refs
(NOLTR-67-20; AD-655229)

A scaling procedure is presented for the case of a shock in a spherically symmetric, exponential, ideal-gas atmosphere. This caling procedure allows a very convenient systemization of the shock pressure-distance curves and leads to a simple method for the investigation of the validity of modified sachs scaling. It is found that modified sachs scaling yeilds pressure–distance curves which are in excellent agreement with results obtained by hydrodynamic code calculations, except in the region where the minimum in overpressure occurs. In this region the deviation is at most 20 per cent. Some comments are made on the applicability of these results to shocks in a horizontally stratified atmosphere. Author (TAB)

N67-36054 National Physical Lab., New Delhi (India). Radio Propagation Unit.
IONOSPHERE PREDICTIONS FOR SEPTEMBER 1967
May 1967 4 p Prepared for Radio Res. Comm. CSIR
(RRC-B132)

Predictions of ionospheric conditions for September 1967, compiled in India, are depicted graphically. Median foF_2 and MUF-4000-F_2 values are given for north and south latitudes. A monogram is presented for transforming F_2-zero-MUF and F_2-4000-MUF to equivalent maximum usable frequencies at intermediate transmission distances. A conversion scale to obtain optimum traffic frequencies is included. E.C.

N67-36074# Hermanus Magnetic Observatory (South Africa).
MAGNETIC OBSERVATIONS AT HERMANUS, 1964–1965
1965 93 p *Its* Geophys. Ser. 1, Rept. A.14

The Hermanus Magnetic Observatory is situated at the geographic coordinates: latitude 34° 25'.5 S., longitude 19° 13'.5 E.; and at the geomagnetic coordinates: latitude −33.7, longitude +81°.7. The geomagnetic coordinates are based on coordinates 78°.6 N., 289°.9 E for the geomagnetic north pole. Tabulated data for the 1) mean monthly and annual values of the magnetic elements, 1964–1965, 2) mean hourly values of D, H, and Z, 1964, 3) diurnal variations of D, H, Z, X, and Y for 1964 and 1965, 4) mean hourly values of D, H, and Z, 1965, and 5) harmonic components of the diurnal variations, 1964 and 1965, are presented along with reproductions of magnetograms for the months of 1964 and 1965. A list of publications of the Observatory is given. L.S.

N67-36082*# Maryland Univ., College Park. Dept. of Physics and Astronomy.
MAGNETIC AND VELOCITY EFFECTS ON IONOSPHERIC ELECTRON CURRENT TO CYLINDRICAL ELECTROSTATIC PROBES
Nathan J. Miller (M.S. Thesis) Aug. 1967 52 p refs
(Grant NGR-21-002-060)
(NASA-CR-88356; TR-705) CFSTI: HC $3.00/MF $0.65 CSCL 04A

The present analysis of electron current data from the Explorer 31 satellite probe experiment shows satellite velocity effects and magnetic field effects to be resolvable into separate velocity and magnetic field modulations of current which are superimposed upon some constant electron current. After separation, the manner in which each effect arises is explored in a manner consistent with the data. The results indicate that ionospheric electron current measurements in the accelerating region for cylindrical electrostatic probes may contain a velocity modulation which could increase the current by a factor of two or reduce it by one-half. If the velocity modulations are accounted for, the magnetic modulations can cause fluctuations of from 20 to 60% in the remaining current. Since such current measurements are used to deduce ionospheric electron densities, these velocity and magnetically related electron current modulations should be considered in evaluating ionspheric electrostatic probe data. Author

N67-36109# National Aeronautics and Space Inst., Bandung (Indonesia).
IONOSPHERIC DATA AS OBTAINED BY A ROCKET IN INDONESIA
Budiharto Kusumanto, S. Kisman, and J. Soegijo [1967] 13 p refs Presented at the IQSY-COSPAR Symp., London, Jul. 1967
(Rept.-3)

Information on densities and temperatures of ions and electrons in the ionosphere, obtained from probes carried by a rocket in Indonesia, is given. Comparisons to similar data on other latitudes are made. No positive and decisive conclusions can yet be given, since the data are only preliminary. L.S.

N67-36164# Air Force Cambridge Research Labs., Bedford, Mass. Upper Atmosphere Physics Lab.
VARIATIONS WITH SEASON AND LATITUDE OF DENSITY, TEMPERATURE, AND COMPOSITION IN THE LOWER THERMOSPHERE
K. S. W. Champion Mar. 1967 35 p refs *Its* AF Surveys in Geophys., No. 192
(AFCRL-67-0161; AD-654668)

Analysis of neutral density data has made it possible to extend curves of mean density as a function of latitude and season from 90 to 120 km. There is an approximate isopycnic point at 91 km. Above this point the density variations are reversed from what they are at 80 km. In other words, at 120 km the density in summer and at the tropics is lower than that in CIRA 1965 and in winter the density is higher. The density curves have been idealized near 120 km to join at one of three points. These correspond to typical summer and tropical conditions, winter conditions, and spring/autumn conditions. The summer density is 20 percent below that of the U.S. Standard, the winter density is 50 percent above the Standard and the spring/autumn density is 1 percent above the Standard. By application of appropriate theory the corresponding variations in temperature and mean molecular weight have been calculated. An unexpected result of the theory is the prediction of a seasonal variation of the mean molecular weight. Some of the data presented in the paper have been analyzed since the models were derived. These data have been found to be acceptably close to the models. Author (TAB)

N67-36177*# Farnham (Frank C.) Co., Philadelphia, Pa.
MATHEMATICAL INTERRELATIONSHIPS IN THE SIZE DISTRIBUTION OF ATMOSPHERIC AEROSOLS ABOVE THE CONTINENT [GESETZMAESSIGKEITEN IN DER GROESSENVERTEILUNG ATMOSPHAERISCHER AEROSOLE UEBER DEM KONTINENT]
Chr. Junge Washington, NASA, Jul. 1967 35 p refs Transl. into ENGLISH from Ber. Deut. Wetterdienst. (West Germany), no. 35, 1951 p 261–277
(Contract NASw-1497)
(NASA-TT-F-11091) CSCL 04A

No comprehensive presentation of the complete size distribution of the particles in the atmospheric aerosol has yet been carried out. By extending and combining known measuring methods, it is possible to comprehend the entire particle size range for $r \geq 5 \times 10^{-5}$ to a good approximation. The results of measurements show that the size distribution in an aerosol at the edge of a

large city can be represented in this range by a simple exponential law. The mixing of different types of smoke, with their individual particle size distributions, together with the process of coagulation, plays an essential role. A survey concerning the synthesis and formation of the overall atmospheric aerosol is given. The distribution law which is discovered provides the key to many questions concerning the optical properties of haze. Results show that the distribution law must possess generally applicable characteristics. The much-disputed maritime component of the aerosol was localized according to its size distribution. Some bioclimatic questions are considered. Author

N67-36190 National Aeronautics and Space Inst., Bandung (Indonesia).
[SLANTNESS OF RECORDINGS FROM A ROCKET-BORNE IONOSPHERE PAYLOAD]
Kusumanto and J. Soegijo 1967 2 p refs
(Rept.-6)

Slantness of a part of recordings from a rocket-borne ionosphere payload presumed to be horizontal and defined in this case as parallel to the frequency axis is examined. A strong correlation existed between mentioned slantness and a time-dependent quantity, when the rocket traversed a certain layer in the ionosphere. Author

N67-36195# Comissao Nacional de Atividades Espaciais, Sao Jose Dos Campos (Brazil). Laboratorio de Fisica Espacial.
TOTAL ELECTRON CONTENT MEASUREMENTS BY DIFFERENTIAL FARADAY ROTATION METHOD AT LOW LATITUDES
O. G. Almeida and H. Waldman 20 Apr. 1967 71 p refs
(LAFE-56) CFSTI: HC $3.00/MF $0.65

Extensive measurements of electron content have been made all over the world with the use of beacon frequencies of artificial satellites. Set of measurements of this kind is presented to aid in understanding the ionospheric processes in Brazilian latitudes at the time of a minimum of the solar cycle. Satellite S-66-B was used for measurements of Faraday rotation angles for two closely spaced frequencies (40 and 41 MHz), as well as Doppler shifts. Computer programs and data reduction routines were established in order to evaluate the total electron content as measured. A technique of closely spaced frequencies provides a simple method for application of the correction to the second-order effects over the Faraday rotation angle. The satellite motion across the region of quasi-transversal propagation strongly affects the accuracy of measurements, however this unwanted effect was eliminated by a smoothing technique. The analysis was made with special attention given to total electron content variations associated with local time, equatorial anomaly, and the Brazilian magnetic anomaly. Author

N67-36228# Rhode Island Univ., Kingston. Dept. of Electrical Engineering.
HYDROMAGNETIC WAVES IN THE IONOSPHERE: PROPAGATION THROUGH INHOMOGENEOUS AND CURRENT CARRYING REGIONS
Muhammad Abbas 1 Apr. 1967 140 p refs
(Contract AF 19(628)-4950)
(AFCRL-67-0236; SR-1; AD-655091)

The report is concerned with the analysis of hydromagnetic waves which are generated in various regions of the magnetosphere and propagated to the earth in the extremely low frequency spectrum. Two different aspects of the problem are investigated, namely, propagation through inhomogeneous regions of the ionosphere and propagation and excitation of waves in current carrying regions of the ionosphere and the magnetosphere. Propagation through inhomogeneous regions is studied by two different methods: Transmission coefficients for hydromagnetic waves are obtained by assuming a linearly varying inhomogeneous region and by transforming the wave equation into a hypergeometric equation such that various types of inhomogeneities can be handled (Epstein theory). Assuming a hydromagnetic wave incident from above and propagating parallel to the earths magnetic field, power transmission coefficients are calculated for various times of day. Propagation of hydromagnetic waves through a current carrying plasma is investigated on the basis of macroscopic equations in which additional terms arising from the presence of a constant current density are included. A general dispersion relation for small amplitude waves is derived. For propagation normal to the steady magnetic field, when the currents are normal to both, the direction of propagation and the static magnetic field, it is found that amplification takes place. For longitudinal propagation with currents in the transverse plane, the propagation constant remains unaffected. For longitudinal propagation, with currents also along the direction of propagation, the propagation constant has a resonance at the ion-cyclotron frequency for both, right and left hand polarization. Author (TAB)

N67-36232* Volt Technical Corp., Washington, D. C.
DIRECT MEASUREMENTS OF DAYTIME AND NIGHTTIME PROFILES OF CHARGED PARTICLE CONCENTRATION BELOW 80 KM [PRYAMYYE IZMERENIYA DNEVNOGO I NOCHNOGO PROFILEY KONTSENTRATSII ZARYAZHENNYKH CHASTITS NIZHE 80 KM]
Yu. A. Bragin 13 Sep. 1967 4 p refs Transl. into ENGLISH from Kosmich. Issled. Izd. Nauk, Vol. 5, no. 3, 1967 p 78–79
(Contract NAS5-12487)
(NASA-CR-88280; ST-PF-AI-10648) CSCL 04A

Certain possible causes are discussed for the formation of local diurnal minima of ion concentration in the stratosphere on the basis of measurements of daytime and nighttime profiles of charged particle concentration below 80 km. Author

N67-36238 National Aeronautics and Space Inst., Bandung (Indonesia).
A REVIEW OF IONOSPHERIC DATA IS OBTAINED BY A ROCKET IN INDONESIA
Kusumanto [1967] 1 p refs
(Rept.-7)

A short review of results obtained by a resonance rectification probe is given. No significant differences existed in electron and ion densities compared to data at other geomagnetic altitudes. Regression of a certain set of electron temperatures, however, showed an unusual curve of electron temperature versus height, probably caused by slanting of the observed recordings with respect to the frequency axis. Author

N67-36302*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
AN ANALYSIS OF THE MOLECULAR KINETICS OF THE THERMOSPHERE PROBE
James O. Ballance 31 Jul. 1967 42 p refs
(NASA-TM-X-53641) CSCL 04A

A Monte Carlo computer analysis of the free molecular flow characteristics of the thermosphere probe used to measure gas temperature and density in the altitude range of 140 kilometers to 350 kilometers is described. The transmission probability which is required to relate the ambient density to the measured density is calculated for a simplified geometric configuration which compares well with measured signals except at high angles of attack where the simplified model of the system fails. The time response of the system seems to be adequate for the mode of measurements; and comparison with measured signals indicates that the incoming molecules made no more than one specular reflection if, indeed, any at all. Author

N67-36392*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

THE GLOBAL RADIATION BALANCE OF THE EARTH ATMOSPHERE SYSTEM OBTAINED FROM RADIATION DATA OF THE METEOROLOGICAL SATELLITE NIMBUS II

Ehrhard Raschke and Musa Pasternak Aug. 1967 24 p refs
(NASA-TM-X-55896; X-622-67-383) CSCL 04A

The meteorological satellite Nimbus II measured the reflected solar radiation in the spectral range from 0.2 to 4.0 microns and the emitted thermal radiation in the spectral range from 5.0 to 30.0 microns over the entire globe during period of about 2.5 months (16 May to 28 July, 1966). These measurements were obtained with a medium resolution scanning radiometer. Thus, to compute the outgoing fluxes of reflected solar radiation and of emitted thermal radiation, empirical integration methods had to be applied to the measured data. For the computation of the emitted thermal radiation a method was used. Functional relations were derived from balloon, airplane, and satellite measurements of reflected solar radiation to account for the angular dependence of the reflectivity of the earth–atmosphere system in calculating the flux of reflected solar radiation. Results were obtained for five subperiods each of half a month's duration. Global maps are presented and discussed showing the geographic distribution of the albedo, the absorbed solar radiation, the emitted thermal radiation, and the radiation balance, obtained from the Nimbus II measurements. Author

N67-36401# Arizona Univ., Tucson.

AN INVESTIGATION OF HEAT TRANSFER FROM BARE SOIL Final Report, Jun. 10–Aug. 20, 1965

W. D. Sellers and P. S. Dryden Apr. 1967 76 p refs
(Grant DA-AMC-28-043-66-G27)
(AD-654780)

The paper contains data on heat transfer from bare soil under stability conditions ranging from very stable to very unstable; and a check on the accuracy of the fluxometer as an instrument for estimating the vapor flux from bare soil. Author (TAB)

N67-36426# White Sands Missile Range, N. Mex. Atmospheric Sciences Lab.

A STUDY OF ATMOSPHERIC DUST, NOVEMBER 1964–AUGUST 1965

G. B. Hoidale, S. M. Smith, A. J. Blanco, and T. L. Barber Mar. 1967 141 p refs
(ECOM-5067; AD-654990)

This report discusses the techniques used in and the results of an investigation of the mineral constituency of the dust component of the atmospheric aerosol over White Sands Missile Range, New Mexico, conducted from November 1964 to August 1965. The eighty-one atmospheric dust samples, taken near the surface during this period, were analyzed by the light microscope technique of dispersion staining and by infrared absorption spectroscopy. Dispersion staining was used to determine the concentrations of quartz, kaolinite, illite, gypsum, and the carbonate family when the particle diameters were greater than four microns. Cases of exceptionally high concentrations of gypsum, quartz, and kaolinite, the month-by-month variation of the composite concentration, the seasonal variation of the gypsum concentration, and the lowest single-sample composite concentration are discussed in relation to the mineral content of area soils and meteorological conditions. Comments are made relative to the possible influence of extraterrestrial and sea-salt particles on the observed concentrations. By extending infrared absorption spectra to 40 microns wavelength, it has been possible to identify the minerals gypsum, mirabilite, quartz, kaolinite, illite, calcite, and dolomite in microgram samples of atmospheric dust, although any particular sample might reveal only a few of these constituents. Author (TAB)

N67-36441# Bureau of Mineral Resources, Geology and Geophysics, Canberra (Australia).

VOLCANIC CAULDRONS, RING COMPLEXES, AND ASSOCIATED GRANITES OF THE GEORGETOWN INLIER, QUEENSLAND

C. D. Branch 1966 205 p refs *Its* Bull. No. 76

The principal rock units and structure of rock in the Featherbed, Croydon, Scardons, Nanyeta, Glen Gordon, Kallon, Gingerella, Cumberland Range, and Galloway Cauldron Subsidence areas are presented. The principal rock units and general structure of rock in the Bagstowe, Lochabar, Warby, Claret Creek, Boxwood, and Doolan Ring Complexes, are given. The main characteristics of the upper palaeozoic acid igneous province; the origin of the magma for acid phyroclastic flows and related high level granites; the evolution of ring complexes; the source of eruption for pyroclastic flows; and an intrusion hypotheses for fractionated acid magma, are discussed. Petrological nomenclature, and rock features are described. L.S.

N67-36446* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

ELECTRON DENSITIES AND SCALE HEIGHTS IN THE TOPSIDE IONOSPHERE: ALOUETTE I OBSERVATIONS OVER THE AMERICAN CONTINENTS. VOLUME IV: SUMMARY GRAPHS

Kwok-long Chan, Lawrence Colin, and John O. Thomas Washington, NASA, 1967 324 p
(NASA-SP-3034) CSCL 04A

Electron density and plasma scale height at various heights and times in the topside ionosphere are presented. They were computed and plotted from Alouette I topside sounder ionograms, made available by the World Data Center. The more-than 10,000 ionograms selected for analysis and presentation were chosen for their nearly complete latitudinal coverage over the American continents. Graphs of both electron density and scale height data, summarizing the results of the first three volumes in this series, are presented, and indexes to the summary graphs are listed. The graphs fall into three main categories: (1) variations of electron density and scale height at fixed altitudes below the individual satellite orbits, (2) latitudinal variations of the seasonal average of electron density and scale height at fixed altitudes for 1-hour local-time increments, and (3) diurnal variations of the seasonal average of electron density and scale height at fixed altitudes for 5° dip latitude increments. R.U.

N67-36451*# Smithsonian Astrophysical Observatory, Cambridge, Mass.

RECENT RESULTS IN THE ATMOSPHERIC REGION ABOVE 200 KM AND COMPARISONS WITH CIRA 1965

L. G. Jacchia 7 Jul. 1967 31 p refs Presented at the 9th Meeting of COSPAR, London, 23–29 Jul. 1967
(Grant NsG-87-60)
(NASA-CR-88351; SAO Special Rept.-245) CFSTI: HC $3.00/MF $0.65 CSCL 04A

Density, temperature, and composition measurements in the upper atmosphere region above 200 km, are presented and compared to similar measurements made in 1965. Results for diurnal variations, solar activity effects, and geomagnetic activity effects on the region are also presented. The semiannual variation of helium and hydrogen in the region, and seasonal variations at higher latitudes, are given. A list of references and a bibliography is included. L.S.

N67-36463# Smithsonian Astrophysical Observatory, Cambridge, Mass.

GEODETIC PARAMETERS FOR A 1966 SMITHSONIAN INSTITUTION STANDARD EARTH, VOLUME 2

Charles A. Ludquist and George Veis, ed. 1966 307 p refs
(SAO Special Rept.-200, Vol. 2) CFSTI: HC $3.00/MF $0.65

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N67-36464# Smithsonian Astrophysical Observatory, Cambridge, Mass.

GEODETIC CONNECTIONS OF THE STATIONS

A. Girnius and J. Rolff *In its* Geodetic Parameters for a 1966 Smithsonian Inst. Standard Earth, Vol. 2 1966 p 1–14 (See N67-36463 21-13)

Control points not too distant from tracking stations were connected geodetically to the Baker–Nunn camera stations and local geodetic control nets by personnel from the observatory. The latitude, longitude, and elevation pertaining to the intersection of the three axes of the camera are tabulated. It is noted that the intersection of the axes of a Baker–Nunn camera is never more than a few decimeters from the movable optical center of the camera. The elevations are given with reference to the mean sea level; and when geoidal maps were available, they were reduced to ellipsoidal heights. The estimated uncertainties are to the nearest geodetic control points. Data recorded are from North America, Europe, South America, Africa, Australia, Japan, India, Argentina, and Hawaii. R.U.

N67-36465# Smithsonian Astrophysical Observatory, Cambridge, Mass.

GEOMETRIC RESULTS

L. Aardoom, A. Girnius, and G. Veis *In its* Geodetic Parameters for a 1966 Smithsonian Inst. Standard Earth, Vol. 2 1966 p 15–58 (See N67-36463 21-13)

Precisely reduced astrophysical data and synthetic simultaneous observations of 30 lines were used to determine the direction of 28 lines, with the aid of 12 satellites used as a target. Of the 28 lines, 10 had enough synthetic observations to be considered as offering reliable directions. Synthetic observations totaling 1660 pairs were obtained by interpolation with an average number of six independent observations for each synthetic observation. Average standard deviation of each synthetic observation was between ± 1 and ± 2 arcsec. R.U.

N67-36466# Smithsonian Astrophysical Observatory, Cambridge, Mass.

RESULTS FROM THE ORBITAL METHOD

G. Veis *In its* Geodetic Parameters for a 1966 Smithsonian Inst. Standard Earth, Vol. 2 1966 p 59–66 (See N67-36463 21-13)

Two separate satellite orbits were determined for each orbital arc by means of both Izsak's and Anderle's tesseral harmonics. Solutions from two sets of tesseral harmonics were combined to eliminate the effect of errors in the coefficients, and also to obtain a numerical indication of the possible effect of these errors. Each of the four satellites is treated separately and the individual results combined in a weighted mean value. There are therefore eight different solutions from both sets of harmonics. R.U.

N67-36467# Smithsonian Astrophysical Observatory, Cambridge, Mass.

THE ZONAL HARMONIC COEFFICIENTS

Y. Kozai *In its* Geodetic Parameters for a 1966 Smithsonian Inst. Standard Earth, Vol. 2 1966 p 67–104 (See N67-36463 21-13)

Greater reliability was obtained in the determination of zonal harmonic coefficients, using Baker–Nunn camera observations from several satellites. Both odd and even harmonics are discussed, and results of two sets of solutions derived are presented. Numerous tables depict data from the several satellites, including parameters. R.U.

N67-36468# Smithsonian Astrophysical Observatory, Cambridge, Mass.

TESSERAL HARMONIC COEFFICIENTS AND STATION COORDINATES FROM THE DYNAMIC METHOD

E. M. Gaposchkin *In its* Geodetic Parameters for a 1966 Smithsonian Inst. Standard Earth, Vol. 2 1966 p 105–258 (See N67-36463 21-13)

Theoretical formulation is presented on the dynamic method of locating station coordinates. Difficulty was encountered in establishing good orbits for satellites, but when the effects of the resonant harmonics were accounted for analytically, the difficulty disappeared. The orbital arcs had at least 60 observations, and were determined from information derived on the gravity field, tesseral harmonics, long-period zonal harmonics, short-period oblateness perturbations, and motion of the pole. An iterative solution is discussed. R.U.

N67-36469# Smithsonian Astrophysical Observatory, Cambridge, Mass.

COMBINATION OF GEOMETRIC AND DYNAMIC RESULTS

W. Koehnlein *In its* Geodetic Parameters for a 1966 Smithsonian Inst. Standard Earth, Vol. 2 1966 p 259–300 (See N67-36463 21-13)

Dynamic and geometric methods were combined to determine new corrections to camera station coordinates and to the nonzonal coefficients of the earth's gravitational potential. The mathematical procedure is briefly sketched, and the numerical analysis was carried out in three iterative cycles. The Baker–Nunn camera observations lead to absolute space directions between observation station and satellite; in the dynamic case, these observations can be directly taken, while in the geometric method the observations from station pairs to a satellite must also be simultaneous. R.U.

N67-36473# Bureau of Mineral Resources, Geology and Geophysics, Canberra (Australia).

MAGNETIC MEAN HOURLY VALUES FROM WATHEROO OBSERVATORY, WESTERN AUSTRALIA 1955–1956

P. M. McGregor 1966 122 p refs

(Rept.-119)

Tabular data are presented on hourly and monthly mean values of the magnetic elements, and daily Fourier coefficients, derived from normal magnetograms produced at Watheroo Observatory, Western Australia, during 1955 and 1956. Also listed are temperature coefficients, baseline values, hourly values, monthly and annual means, quiet day diurnal variation, magnetic activity, and magnetograms. R.U.

N67-36485*# State Univ. of Iowa, Iowa City. Dept. of Physics and Astronomy.

SIMULTANEOUS SATELLITE AND BALLOON OBSERVATIONS OF THE SAME AURORAL ZONE PRECIPITATION EVENT

D. W. Milton (Calif. Univ., Berkeley) and M. N. Oliven Jun. 1967 26 p refs Sponsored in part by NASA

(Contract Nonr-1509(06); Grant NSF GP-5583)

(NASA-TM-X-60236; Rept.-67-20; AD-654406) CSCL 04A

On September 20, 1963 the Injun III satellite, at an altitude of 2350 km, passed within close proximity of a balloon X-ray detector at 35 km altitude. During a transit of the L-shell of the balloon, a marked correlation in the increases of flux of the satellite precipitating electron E=or >40 KeV detector and the balloon X-ray E=or>30 KeV detector is found. These results place a lower limit of 430 km east–west separation of the mutually observed pulsation event. Author (TAB)

N67-36529# Joint Publications Research Service, Washington, D. C.

SOVIET-BLOC RESEARCH IN GEOPHYSICS, ASTRONOMY, AND SPACE

6 Sep. 1967 163 p refs Transl. into ENGLISH from Russian (JPRS-42481; TT-61-11147-163; Rept.-163)

Soviet open literature sources are surveyed on recent publications covering astronomy, geophysics, meteorology, oceanography, and space science topics. Abstracts, and translations of news articles are provided on such areas of interest as: electrophotometer for studying the spectrum of limb flares, visible distribution of sporadic meteor radiants, dependence of optical spectrum of quasars on their red shift, analytical representation of space motions, effect of Venusian cloud cover on its radio emission, recession of galaxies and neutrinos in cosmos, method for evaluating corona discharge currents from natural points, physical and chemical nature of atmospheric aerosols, influence of orography in numerical forecasting, decoding oceanographic information with a computer, zoning oceans for hydrometeorological purposes, and permafrost research. R.U.

N67-36566* Kansas Univ., Lawrence. Center for Research, Inc. Engineering Science Div.

INVESTIGATION OF CROSS-POLARIZED RADAR ON VOLCANIC ROCKS

Elliot Gillerman Feb. 1967 12 p refs

(Contract NSR-17-004-003)

(NASA-CR-88081; CRES-TR-61-25) CSCL 08G

A number of areas of volcanic rocks, mostly in the southwestern United States, exhibit differences in radar return on simultaneously produced like-polarized and cross-polarized K-band radar imagery. Preliminary investigations have failed to afford conclusive proof that this is due to the glass content of the rock. Roughness, degree and type of vegetation cover, and perhaps age of the rocks may be contributing factors. Additional investigations, including microscopic studies, now underway, will be necessary to determine more accurately the subtle effects of mineral composition, texture, and glass content on radar return. Author

N67-36612*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

INTERFERENCE OF PROPERTIES OF THE EARTH FROM SATELLITE MEASUREMENTS OF INFRARED EMISSION

W. Nordberg Aug. 1967 21 p refs Presented at the Thermophys. Specialist Conf., New Orleans, 17–20 Apr. 1967

(NASA-TM-X-55910; X-624-67-408) CSCL 08E

The constraints imposed by spacecraft technology limitations as well as by the physical properties of emitting surfaces in relation to atmospheric absorption and reemission are considered in conjunction with example data obtained from meteorological satellites with relatively simple instrumentation. Available remote sensing instrumentation is briefly analyzed in terms of ability to provide necessary accuracy, resolution, calibration, and geographic coverage. Considerations for deriving geophysical quantities from radiation measurements are assessed. E.C.

14 INSTRUMENTATION AND PHOTOGRAPHY

Includes design, installation, and testing of instrumentation systems; gyroscopes; measuring instruments and gages; recorders; transducers; aerial photography; and telescopes and cameras.

N67-35335 Joint Publications Research Service, Washington, D. C.

IMPROVING THE METHOD FOR CHECKING ACTINOMETRIC INSTRUMENTS IN THE LABORATORY

V. A. Kleventsova *In its* New Methods in Meteorl. Meas. 26 May 1967 p 34–38 refs (See N67-35331 21-20)

The results of testing different methods for the checking of actinometric instruments in the laboratory are presented. These results indicate the possibility of some simplification of the adopted checking method. First, it is recommended that the use of a control instrument be abandoned, provided a constant voltage is maintained in the lamp, and second, that a high-impedance mirror galvanometer is used in determining the sensitivity of the instruments. In the case of large-scale checking of instruments this reduces the time required for the checking and simplifies computations. When this method is used the random error in checking is decreased. Author

N67-35356# Ballistic Research Labs., Aberdeen Proving Ground, Md.

DYNAMIC CALIBRATION OF PRESSURE TRANSDUCERS AT THE BRL SHOCK TUBE FACILITY

George A. Coulter May 1967 48 p refs

(BRL-MR-1843; AD-654508)

Dynamic pulse calibration methods and types of pulse calibrators currently in use at the Ballistic Research Laboratories (BRL) shock tube facility are described. Records typical of the various calibration methods obtained from piezoelectric tourmaline transducers are shown. Results from the various calibration methods are found to be in agreement with each other within plus or minus 1.5 percent. Author (TAB)

N67-35358*# Raytheon Co., Sudbury, Mass. Space and Information Systems Div.

FEASIBILITY STUDY FOR A HYDROGEN GAS LEAK DETECTION SYSTEM AS REQUIRED FOR USE ON INFLIGHT EXPERIMENTS Final Report, 1 Jul. 1966–25 Jan. 1967

25 Jan. 1967 107 p refs

(Contract NAS8-18041)

(NASA-CR-88629; U67-4041) CFSTI: HC $3.00/MF $0.65 CSCL 14B

A breadboard model of the leak detector system consisting of a Varadi RF mass spectrometer tube, a solid-state electrometer, and a two-frequency RF driver was fabricated and tested using standard laboratory power supplies. Results of these tests demonstrated the feasibility of this system for application on project THERMO. A 100 millisecond response time over the pressure range from 7×10^{-3} to $\approx10^{-7}$ Torr was obtained. The system detected less than 1% H_2 in a helium atmosphere at 10^{-5} Torr. Total system weight is less than 2.2 pounds. Power input requirements are less than 12 watts. Complete data is presented and major problems together with their solutions are discussed. In addition, a flight system is recommended using the design principals demonstrated by Phase B of this program. Major problems together with their solutions, are discussed. Author

N67-35360* ITT Industrial Labs., Fort Wayne, Ind.
HIGH RESOLUTION NIGHTTIME CLOUD-COVER RADIOMETER Quarterly Report, Apr. 1–Jul. 21, 1967
P. C. Murray, W. H. Wallschlaeger, R. Pownall, and L. Owens 11 Aug. 1967 207 p
(Contract NAS5-668)
(NASA-CR-87983; QR-23) CSCL 20F

The test programs for one prototype and two flight models of the Nimbus high resolution infrared nighttime cloud cover radiometer are summarized. Also included are changes incorporated during this period in the test procedures for video temperature compensation and in the design of the daytime albedo simulator concerning its day–night gain. R.N.A.

N67-35392# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
DEVICE FOR PROTECTING AND UNCOVERING AN INSTRUMENT SENSOR IN A VACUUM [USTROYSTVO DLYA ZASHCHITY I VSKRYTIYA VAKUUMIROVANNOGO DATCHIKA PRIBORA]
O. Ye. Lebedev, G. N. Levina, V. T. Lepekhina, M. L. Libman, and G. M. Martynekevich 23 Feb. 1967 8 p Transl. into ENGLISH from Russian Patent No. 175398 (Appl. No. 925209/26-25, 12 Oct. 1964 2 p
(FTD-HT-66-669; AD-655015)

The paper introduces an arrangement for protecting and uncovering an evacuated gauge of a device while introducing the gauge into the investigated medium. The arrangement contains a sealed hood connected to the nipple of the device and a mechanism for destroying this hood. To make sure that the investigated medium enters the gauge and to protect the gauge from damage while it is being uncovered, the hood is made up of two metallic parts fixed to one another and to the nipple with airtight glass seams. The parts of the hood are also provided with earlike holders which are connected to the hood-destroying mechanism. Author (TAB)

N67-35440# Oak Ridge National Lab., Tenn.
ANALYSIS OF PULSE-HEIGHT ANALYZER TEST DATA WITH A SMALL COMPUTER
E. McDaniel and J. W. Woody, Jr. 17 May 1967 56 p
(Contract W-7405-ENG-26)
(ORNL-TM-1865) CFSTI: HC $3.00/MF $0.65

All multichannel pulse-height analyzers purchased by ORNL are tested to determine whether they are acceptable to the Laboratory. A PDP-8 computer program was prepared for evaluation of these test data, that is, to determine the extent of the integral and differential nonlinearities of the instruments. The program will also examine smooth spectra of radioactive decay. Author (NSA)

N67-35453# California Univ., Livermore. Lawrence Radiation Lab.
METHOD FOR THE NUMERICAL ANALYSIS OF PRESSURE TRANSDUCER RECORDS
Richard J. Wasley and Franklin E. Walker 10 Apr. 1967 11 p refs
(Contract W-7405-ENG-48)
(UCRL-50233) CFSTI: HC $3.00/MF $0.65

This report describes a mathematical treatment and an associated FORTRAN program that are used in the analysis of pressure transducer records obtained in one-dimensional strain impact experiments. Author (NSA)

N67-35466# General Precision, Inc., Binghamton, N. Y. Link Group.
SYNTHESIZED ADI FOR PITCH-SCALE APPRAISAL Technical Report, 5 Nov. 1965–30 Jun. 1966
William R. Auston, David L. Sykora, and Samuel H. Bordonaro Wright-Patterson AFB, Ohio. AF Flight Dyn. Lab., May 1967 24 p
(Contracts AF 33(615)-2895; AF 33(615)-3952)
(AFFDL-TR-67-36; AD-655111)

A Photographic Instrument Synthesizer System was developed to provide an economical approach to the evaluation of new concepts in aircraft instrument design. The synthesizer system presents these concepts in the form of a 16 mm motion picture which enables instrument designers to view a proposed instrument in a dynamic mode prior to prototype development. Six studies were conducted synthesizing an attitude director indicator (ADI) for a variety of pitch-scale appraisals. An iterative approach was used to develop the instrument concept. Each film was revised to incorporate the changes recommended from the appraisal of each preceding film. The report provides an engineering description of the six instrument concepts and discusses the results of each film review. The first four concepts are concerned with modifying the aircraft symbol to increase pitch scale readability. The last two concepts are concerned with an expanded pitch scale superimposed on the attitude sphere. The intent of these concepts is to provide information to aid instrument designers in developing an ADI with increased readibility. Author (TAB)

N67-35477# Northeastern Univ., Boston, Mass.
A ROCKET INSTRUMENT FOR THE MEASUREMENT OF DAY AIRGLOW
Alan D. Bailey and Richard E. Grojean 28 Feb. 1967 64 p refs
(Contract AF 19(628)-3878)
(AFCRL-67-0257; SR-3; AD-654693)

Description is given of the design and construction of a rocket borne instrument for the measurement of day airglow emissions. Design criteria included greater sensitivity, background discrimination, in-flight spectral calibration and increased spectral information. A scanning photometer was designed utilizing matched interference filter pairs mounted in a rotating turret and displaced approximately 5 degrees to one another. Two matched parallel light beams produced by a beam splitter are passed through the matched interference filter pair. The resulting scans are displaced in the spectrum by 10A and provide output signals from closely adjacent spectral regions. Measuring the difference in the two signals provides emission line information and discriminates against background. The sum of the signals provides the background information. Polarizing effects corrected by use of polaroid filters at the input aperture resulted in an overall reduction in sensitivity of the instrument. Author (TAB)

N67-35489# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
A HIGH-SPEED PHOTORECORDER WITH FILAMENT OPTICS AND AN ELECTRO-OPTICAL CONVERTER [SKOROSTNOY FOTOREGISTRATOR S VOLOKONNOY OPTIKOY I ELEKTRONNO OPTICHESKIM PREOBRAZOVATELEM]
N. A. Valvus, G. S. Arushanov, and V. P. Generalova 27 Feb. 1967 10 p Transl. into ENGLISH from An SSSR. Komis. po Nauchnoy Fotogr. i Kinematogr. Usp. Nauchnoy Fotogr. (Ukrania), v. 9, 1964 p 33–36
(FTD-HT-67-9; TT-67-62253; AD-654664)

The article considers a high-speed photorecorder with filament optics and an electro-optical converter which makes it possible to photograph high-speed processes at a frame speed of up to 10 to the 10th power per second. This number of frames per second can be photographed due to the application of a special optical cell, which is made from optical filaments, and an electro-optical converter. TAB

N67-35490# Raytheon Co., Alexandria, Va. Autometric Operation.
ULTRA PRECISION BASE LINE MEASUREMENT PROGRAM
Final Report, 1 Feb. 1966–2 Mar. 1967
Melvin L. Lowry, Soren W. Henriksen and Alan Hurkamp 1 Feb. 1967 97 p refs
(Contract AF 19(628)-5878)
(FR-67-189; AFCRL-67-0162; AD-655099)

This report discusses the fundamental methods of precise base line measurement, i.e., measurement of propagation time of electro-magnetic energy, and interferometric comparisons of an unknown distance to an established standard length. The limitations and possible methods of correction of the limitations are discussed. The general design consideration and a discussion of a modified Vaisala base line are presented. The approach to the design of an optical delay line and its calibration as a field portable etalon are included. The design and use of a three-color laser refractometer to provide the required compensation for refractive index changes is presented. The operation characteristics, the data-taking procedure, and size, shape, weight, and limitation of a van portable system, are discussed. Author (TAB)

N67-35533*# Kansas Univ., Lawrence. Remote Sensing Lab.
IDENTIFICATION OF REMOTE OBJECTS BY MEANS OF SCATTEROMETRY DATA AND APPLICATION TO PISGAH CRATER
G. W. Dalke Feb. 1967 27 p refs
(Contract NSR-17-004-003)
(NASA-CR-88010; CRES-61-17) CSCL 17I

This report discusses the possibility of using scatterometry data for identifying remote objects. An identification algorithm based on statistical decision theory is given and some characteristics of a multiple category system are discussed. Like- and cross-polarized, multiple incidence X-band scatterometry data obtained over Pisgah Crater, California were identified relative to 10 categories. The same data were used for both generalization and training and the total probability of correct classification was 97%. Author

N67-35540*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
PRELIMINARY RESULTS FROM AIRCRAFT FLIGHT TESTS OF AN ELECTRICALLY SCANNING MICROWAVE RADIOMETER
C. Catoe, W. Nordberg, P. Thaddeus, and G. Ling Aug. 1967 40 p refs
(NASA-TM-X-55893; X-622-67-352) CSCL 20F

The radiometer was designed to make the first global microwave studies of the earth from a meteorological satellite. The model described in this paper represents the aircraft prototype of the satellite flight model and was tested in aircraft flights over Arctic Ocean ice, Alaskan tundra and snow, Southwestern U.S. desert, Eastern and Midwest U.S. farmland, Yucatan tropical forests, and storm and rain clouds over land and water. The tests proved the feasibility of extending the spectral range of meteorological satellite radiation measurements from the infrared regions to the longer microwave wavelengths (1.55 cm). The radiometer consists of a microwave receiver and a two-dimensional, 18×18-inch phased array antenna. Indications are that the mapping was achieved with the desired spatial resolution and radiometric accuracy. The tests proved that scanning microwave radiometry will be useful for mapping areas of heavy rainfall and the extent and thickness of sea ice independent of cloud conditions. K.W.

N67-35672*# Midwest Research Inst., Kansas City, Mo.
STUDY OF LOW PRESSURE APPLICATION OF THE ORBITRON
Paul J. Bryant and Charles M. Gosselin Washington, NASA, Sep. 1967 24 p refs
(Contract NAS1-6279)
(NASA-CR-886) CFSTI: HC$3.00/MF$0.65 CSCL 14B

Orbitron vacuum gauge performance is reported with emphasis on low pressure response characteristics. A linear ion current to pressure response was found for the ultrahigh vacuum range 10^{-8} to 10^{-12} torr. A sensitivity of 0.02 A/torr (dry air equivalent) was measured for a 1.0 μA emission current setting, and 0.125 A/torr for 10 μA emission. These values correspond to gauge factors of 2×10^{4}/torr and 1.25×10^{4}/torr, respectively. High sensitivity in relation to emission current results from the long orbiting path lengths which ionizing electrons travel. Still higher sensitivities and lower residual pressure equivalents can be obtained by employing longer path lengths. The moderate operation reported here gave very stable response. Residual readings were dependent upon gauge outgassing history indicating a contribution from electronic desorption as well as X-ray photocurrent. A residual of 9×10^{-12} torr (dry air equivalent) was recorded for 1.0 μA emission. Pressure response was determined by direct comparison to special modulated ion gauges and by a pressure ratio technique. Author

N67-35718# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
WIDE ANGLE ORTHOSCOPIC AEROPHOTOGRAPHIC OBJECTIVE
N. A. Agal'tsova and M. M. Rusinov 24 Feb. 1967 7 p Transl. into ENGLISH from Russian Patent No. 178702 (Appl. No. 905392/26-10, 11 Jun. 1964) 2 p
(FTD-HT-66-792; AD-654655)

A wide-angle orthoscopic aerophotographic objective is described which has the distinguishing feature that for the purpose of improving the relative opening with simultaneous aligning of the aerial film the inner positive lenses are separated from the glued-together components by air intervals, and behind the objective and its focal plane there is located a tightening glass. TAB

N67-35727*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
METHODS FOR OBTAINING SURFACE TEMPERATURES OF MATERIALS IN THE PRESENCE OF EXTRANEOUS RADIATION
B. L. Schilling Washington, NASA, Sep. 1967 29 p refs
(NASA-TN-D-4107) CFSTI: HC$3.00/MF$0.65 CSCL 20M

The problem of measuring surface brightness temperatures of materials surrounded by hot radiating gases is discussed. Effects of extraneous radiation on the accuracy of measurements made by various types of pyrometers are considered, and two approaches are presented for obtaining accurate brightness temperature measurements. The first approach consists of correcting the data for effects of extraneous radiation. The second approach employs a variable-wavelength pyrometer in a wavelength region free from such radiation. Experimental data on a charring ablation material obtained with the second approach are presented and compared with data uncorrected for extraneous radiation obtained with a disappearing-filament optical pyrometer and with a total-radiation pyrometer. The results indicate that large amounts of extraneous radiation from the testing environment used are present within the sensitive wavelength regions of the latter two instruments. An error analysis shows that good accuracy in surface temperature measurements is now well within the state of the art for a variable-wavelength pyrometer. The experimental data show that reproducibility of data obtained with such an instrument is extremely good and that the instrument is highly sensitive to small surface temperature changes. Author

N67-35754*# Borg-Warner Controls Div., Borg-Warner Corp., Santa Ana, Calif.
SERVO CONTROL AND DATA SYNCHRONIZATION STUDY
Benton Bejach 15 Jun. 1967 10 p Prepared for JPL
(Contracts NAS7-100; JPL-951659)
(Rept.-70-007-Q2; NASA-CR-88197) CFSTI: HC $3.00/MF $0.65
CSCL 14D

A breadboard of a magnetic tape recorder–reproducer has been developed which is capable of accepting data pulses at varying rates, making maximum usage of storage space by recording data at a constant rate, and retrieving the recorded data at a rate synchronized to an external clock. Testing of the breadboard to date is briefly described and photographs of the breadboard recorder and components and a block diagram of the recorder circuitry are included. R.N.A.

N67-35797# Zentralinstitut fuer Kernforschung, Rossendorf bei Dresden (East Germany).
DEVELOPMENT OF A FLAT IONIZATION CHAMBER FOR THE VA-J-15 VIBRATING CONDENSOR ELECTROMETER FOR β DOSE RATE MEASUREMENTS IN RADIATION PROTECTION [ENTWICKLUNG EINER FLACH KAMMER ZUM VA-J-15 SCHWING KONDENSATORELEKTROMETER FUER β-DOSISLEISTUNGSMESSUNGEN IM STRAHLENSCHUTZ]
Werner Rossbander and Gudrun Haberer Jul. 1966 17 p refs
In GERMAN; ENGLISH summary
(ZFK-DOS-5)

The development of a flat ionization chamber for use with a portable vibrating condensor electrometer is described. The chamber allows the measurement of beta dose rates in the range from 10 mrad h^{-1} to 1000 rad h^{-1} within an error of $\leq \pm 40\%$ for beta radiations with maximum energies between 0.2 and 3.5 MeV, angles of radiation incident between 0° and ±60°, and distances between the source and the chamber of ≥ 10 cm. Author (NSA)

N67-35847# United Kingdom Atomic Energy Authority, Harwell (England). Atomic Energy Research Establishment.
AUTOMATION OF A PHILIPS X-RAY SPECTROGRAPH
J. T. Campbell and T. Hammond Feb. 1967 34 p refs
(AERE-R-4534) CFSTI: HC $3.00/MF $0.65

A Philips fluorescent X-ray spectrograph (TYPE PW1520) was converted for continuous automatic operation, whereby a printed record of angle, counts, and time is made for ten angles which are preselected by the operator. The cycle repeats itself until stopped manually, so that the equipment can be left running unattended for long periods, thus making possible to record during silent hours. Some examples are given demonstrating the advantages in analysis of the automated equipment. Author (NSA)

N67-35854# California Univ., Berkeley. Lawrence Radiation Lab.
HIGH-SENSITIVITY NEUTRON AND PROTON FLUX DETECTOR WITH A PRACTICAL THRESHOLD NEAR 600 MeV, USING Hg (SPALLATION) ^{149}Tb
Joseph B. McCaslin and Lloyd D. Stephens 14 Apr. 1967 28 p refs Presented at the 12th Ann. Meeting of the Health Phys. Soc., Washington, D. C., 18–22 Jun. 1967
(Contract W-7405-ENG-48)
(UCRL-17505; CONF-670610-2) CFSTI: HC $3.00/MF $0.65

Correct evaluation of radiation exposures received by individuals working near high-energy accelerators depends upon measurement of the radiation field involved. The measurements of the separate components and the determination of their energy spectrum are basic to this evaluation. No single instrument or detector can make these measurements; therefore, a variety of detectors must be employed. A detector is described for the measurement of high-energy particles which utilizes the spallation of mercury to ^{149}Tb, an alpha emitter with a 4.12-h half-life. This reaction has a threshold between 500 and 600 MeV, and extends the use of threshold detectors into another energy decade. The Hg→^{149}Tb reaction has been successfully used to measure relative neutron production from targets as a function of angle for energies up to 26 GeV. Author (NSA)

N67-35889# Illinois Univ., Urbana. Nuclear Radiations Lab.
A SHORT NOTE ON E-δE PARTICLE IDENTIFICATION TELESCOPE SYSTEMS
Stephen I. Warshaw Jun. 1967 25 p refs
(Contract N00014-67-A-0305-0005)
(TR-163; AD-654912)

The purpose of the note is to discuss in an elementary way features of E-Delta E solid state detector telescope systems that are of practical interest. While it is true that a large body of literature has already been written on nuclear particle discrimination techniques using these systems, it is felt that this brief discussion will provide a handy reference guide to those who use them. Tables of values for stopping losses in silicon are included also. Author (TAB)

N67-35922# Federal Aviation Agency, Washington, D. C. Test and Evaluation Div.
EVALUATION OF RADAR VIDEO RECORDERS Final Report
Gerald E. Titherington May 1967 32 p
(RD-67-34)

A TV tape recorder was evaluated to determine its operational value for recording and reproducing scan converted radar information. Although there is some degradation from the original live display, the video tape record, which is not normally available, does enable personnel to reconstruct air traffic situations completely and accurately. The off-the-shelf test recorder can be adapted to fulfill FAA requirements at air traffic control facilities having radar surveillance which incorporates the use of scan converters. Author

N67-35928# Harry Diamond Labs., Washington, D. C.
A HIGH PRECISION, REMOTELY SETTABLE ELECTRONIC TIMER SYSTEM
Ronald J. Reyzer Apr. 1967 87 p refs
(HDL-TM-66-18; AD-654349)

The report summarizes the design description and operation of an electronic timer system. The system includes two basic sections - a ground-based setting unit and a remotely located, high precision, dual-channel timer that can generate a sequence of electrical outputs at fixed intervals from the preset time. Each channel is settable in 1-msec increments from 1.000 to 19,999.999 sec. The frequency source is a crystal-controlled oscillator accurate to within 2.5 parts in 10 to the 7th power over a voltage range of 21 to 31 V dc, a temperature range of 0 to 60 C, and a shock and vibration environment of a typical missile launch. The timer is set and monitored by the setting unit, by transmitting commands over a two- or three-wire link or a two-way radio link. For each command sent to the timer, an acknowledgment must be returned; otherwise, the setting process stops and a visual indicator registers an error in setting. An oversized breadboard version of the dual-channel timer was used in the system described; the projected size and weight per unit, however, are 60 cu in. and 3 lb, respectively. Author (TAB)

N67-35939# Georgia Inst. of Tech., Atlanta. Engineering Experiment Station.
A SOLID STATE STEP SCANNER

E. W. Hearn 1 Jun. 1967 9 p
(Contract Nonr-991(09))
(TR-5; AD-654205)

A convenient and versatile step scanner for use either with stepping motors or with standard a.c. induction motors is described. The step scanner provides shaft rotation at any of three speeds in increments from one to nine times the minimum increment size, plus a continuous rotation option. Author (TAB)

N67-35983* Kansas Univ., Lawrence. Center for Research, Inc. Engineering Science Div.
AUTOMATIC PROCESSING OF MULTI-SPECTRAL IMAGES
George W. Dalke [1967] 67 p refs
(Contract NSR-17-004-003)
(NASA-CR-88205; CRES-61-16) CSCL 14E

Three spectra-zonal images taken over Phoenix, Arizona, are used for evaluating an automatic mapping system. Each point on the images is assumed to fall within one of eight categories and statistical decision theory with a Baye's strategy is used to automatically classify the points into these categories. It was found that the probability of correct classification is relatively insensitive to the number of detectable gray levels in the original images; that most classification errors occurred on the spatial boundaries of categories; that the use of multiple images increased the number of detectable categories and reduced the effect of insufficient statistical information. A real time processor with a color coded output for the categories is described and, based on the results of the problem investigated, is recommended for construction. Author

N67-35990# Industrial Nucleonics Corp., Columbus, Ohio.
BETA RADIATION CORROSION DETECTION STUDY, PHASE II Final Report, Apr. 1966–31 May 1967
Albert J. Frasca, Charles H. Bemisderfer, and Charles E. Krause
31 May 1967 77 p refs
(Contract NOw-66-0440-c)
(Rept.-0-0603-FR; AD-654212)

The development of a portable gauge to demonstrate the use of beta radiation for corrosion detection was the primary goal of this program. The gauge was designed for detecting corrosion occurring at the interface between an aluminum substrate and an overlying organic protective coating. From this development program, appreciable insight was acquired for the development of a prototype gauge of this type. Test samples were fabricated from aluminum corrosion products (Al_2O_3) and used for calibration purposes. Laboratory data with these samples indicated that corrosion depths could be detected over a dynamic range of from 2 to about 20 mils with the presently designed gauge. Also, it was quite that the gauge responded quite well to corrosion and pitting on the underside of thin metals such as aluminum and magnesium aircraft skins (skin thickness no greater than 20 mils for maximum sensitivity). The test results with calibrated surface corrosion samples and results of work concerning corrosion detection on the underside of aircraft skins are discussed. Also, photographs of the test results are given for surface and subsurface detection. Author (TAB)

N67-36003*# Kansas Univ., Lawrence. Center for Research, Inc.
THE POTENTIAL OF RADAR AS A REMOTE SENSOR IN AGRICULTURE: 1. A STUDY WITH K-BAND IMAGERY IN WESTERN KANSAS
D. S. Simonett, J. E. Eagleman, A. B. Erhart, D. C. Rhodes, and D. E. Schwarz Mar. 1967 14 p refs
(Contract NSR-17-004-003; Grant NsG-298)
(NASA-CR-88268; CRES-61-21) CSCL 02C

This study is aimed at extracting information on crops from radar imagery, and is confined to an analysis of monopolarization (HH, horizontal transmit and receive), K-band radar. Crop and soil parameters of approximately 400 fields in a 48 square mile test site near Garden City, Kansas, were statistically compared with average film density values from each field. Film densities were obtained from imagery taken during three late summer and autumn imaging flights. Results indicate that percent of ground covered by vegetation, crop height, surface geometry, and moisture content of crops and surface soils significantly affect radar return signal strength. Some agricultural fields, notably sugar beets and bare ground, can be identified with an acceptable probability of accuracy on September (1965) imagery. Others may be discriminated with much less certainty at that time. Accuracy is improved if time (time of planting, maturation, and harvest) is added as a discriminant tool, by obtaining images from different months. Author

N67-36017*# Alabama Univ., University. Bureau of Engineering Research.
THERMAL DESIGN STUDIES Final Report
Feb. 1967 135 p
(Contract NAS8-5270)
(NASA-CR-88135) CSCL 14E

Design, fabrication, and test details are presented on an electromechanical weighted-area integrating device (WAID), which can be used to determine the view factor by integrating over the exposed area of a parabolic mirror photographic image. The WAID consists of a constant speed turntable, an electric contact-type readhead, a summer, an integrator, and a digital voltmeter readout. Derivations are given for the equation to define the view factor; the calibration equation of the parabolic mirror image, from which the weighting factor is determined; and the difference integral equation from which the WAID is designed. To acquire data on some unusual geometries, the WAID was used to two experiments to determine the radiation configuration factor at discrete points on two models. A series of thermal models was designed in which the radiation and conduction exchanges would be of approximately the same order of magnitude, and which would achieve a speed-up in time of 5 and 10. Results reflect the difficulty in speeding up the test by too large a factor. M.G.J.

N67-36021# Deutsches Elektronen-Synchrotron, Hamburg (West Germany).
MAGNETIC SPECTROMETER FOR HIGH-ENERGY ELECTRON SCATTERING EXPERIMENTS
W. Bartel, B. Dudelzak, H. Krehbiel, J. M. McElroy, U. Meyer-Berkhout et al Apr. 1967 20 p refs
(DESY-67/10)

A spectrometer composed of deflecting magnets and magnetic quadrupoles is described which is designed to analyze particles scattered in the angular range 8 to 35° and at incident energies up to 6 GeV. A momentum discrimination between 0.2 and 0.7%, depending on the scattering angle, was achieved. The performance of the spectrometer for the scattering of 5.275-GeV electrons from protons at 12.5° is described. Author (NSA)

N67-36024* Kansas Univ., Lawrence. Center for Research, Inc. Engineering Science Div.
FIELD STUDIES ON VEGETATION AT HORSEFLY MOUNTAIN, OREGON AND ITS RELATION TO RADAR IMAGERY
Stanley A. Morain Jan. 1967 21 p refs
(Contract NSR-17-004-003; Grant NsG-298)
(NASA-CR-88210; CRES-61-22) CSCL 14E

Results of field investigations conducted as part of a continuing study of radar–vegetation relationships are presented. Five major types of vegetation: pine forest, juniper woodlands, grasslands, sagebrush and chaparral are discussed in terms of their appearance in the field, their distribution in the study area, and their radar

appearance. There is good evidence from the results of field and laboratory interpretation that these five types can be separated at least partially with multiple polarization radar images; and provided images at different times are available it should be possible to make clean consistent separation. Some distinctions between types are inherently more difficult because their geometries in the radar wavelengths are very similar. In these cases is is proposed that electronic sensing devices will prove valuable in aiding distinctions invisible to the eye. Author

N67-36034# White Sands Missile Range, N. Mex. Atmospheric Sciences Lab.
A COMPARATIVE EVALUATION OF THE AUTOMATIC TRACKING PILOT-BALLOON WIND MEASURING SYSTEM
Stanley F. Kubinski Apr. 1967 58 p refs
(ECOM-5121; AD-654991)

Limitations of the existing operational double theodolite systems and the need for a better method of measuring wind parameters resulted in the development of the automatic tracking pilot-balloon wind measuring system, utilizing a T-9 radar. The T-9 system was evaluated by comparing wind component profiles generated by the T-9 system and the double theodolite systems tracking the same pilot-balloon to an altitude of 4,000 ft. AGL. Wind component values thus derived were compared. Values of the wind component velocities at points at 500 ft. intervals and the mean component velocities over 500 ft. layers for each profile were recorded. The absolute differences of the values at corresponding points and layers were tabulated. Analysis of the tabulated data shows a mean difference in the order of magnitude of 1.5 MPH. The limitations of the double theodolite systems are discussed, and the apparent advantages gained by the use of the T-9 system are described. Results of the comparison show the T-9 system provides a reliable method of obtaining accurate wind data to 4,000 ft. AGL, with a rapid evaluation of wind parameters. The T-9 system has the capability of measuring wind parameters to 10,000 ft. AGL. It also reduces the complexity of the hardware used in the real time data system (RTDS) and simplifies the RTDS program. Author (TAB)

N67-36042*# Parametrics, Inc., Waltham, Mass.
DEVELOPMENT OF A CHEMILUMINESCENT OZONE DROP-SONDE Final Report
Lester Seiden 15 Jul. 1966 107 p refs
(Contract NAS5-3638)
(NASA-CR-87984) CSCL 14B

The object of this work was to design and construct a drop-sonde instrument capable of measuring atmospheric ozone concentrations (via a chemiluminescent technique) at altitudes up to 65 kilometers. The instrument would be ejected from a rocket at high altitude and descend on a parachute, telemetering measurements during the descent. This report describes the theoretical and experimental studies carried out during the development of the instrument, together with a description of its design and operating principles. In addition to the instrument itself, the necessary apparatus and procedures for carrying out a pre-flight ground calibration are described. Author

N67-36051# Oak Ridge National Lab., Tenn.
GAMMA SPECTROMETRY BASED ON GERMANIUM DETECTORS
L. V. Maslova, O. A. Matveev, S. M. Ryvkin, N. B. Strokan, and A. Kh. Khusainov Jun. 1966 6 p refs Presented at the IAEA Panel Meeting on Lithium-Drifted Germanium Detectors, Vienna, 6–10 Jun. 1966
(ORNL-TR-1651; CONF-660625-4) CFSTI: HC $3.00/MF $0.65

The preparation of electrical contacts on Ge(Li) detectors is discussed. These contacts must be made very carefully in order to obtain high resolution and minimum detector noise. A method for fabrication of germanium detectors is described. It is based on introduction of radiation defects in a germanium crystal. The advantage of these detectors compared with Ge(Li) detectors is the fact that they no not have to be stored at liquid-nitrogen temperatures. The characteristics of these radiation detectors are preserved during storage at room temperature. Author

N67-36058# California Univ., Berkeley. Lawrence Radiation Lab.
REMARKS ON THE USE OF THE SPIRAL READER
Gerald R. Lynch 5 Jan. 1967 22 p Presented at the Am. Phys. Soc. Meeting, Nashville, 2 Dec. 1966
(Contract W-7405-ENG-48)
(UCRL-17328; CONF-661208-4) CFSTI: HC $3.00/MF $0.65

The performance of the Spiral Reader measuring machine is discussed and the device is compared with other machines that measure bubble chamber film. The methods used to filter out tracks from the measured data are described. Author (NSA)

N67-36064*# IIT Research Inst., Chicago, Ill. Astro Sciences Center
OPTICAL IMAGERS FOR THE SMALL EARTH RESOURCES SATELLITE
S. S. Verner Apr. 1967 53 p
(Contract NASr-65(10))
(NASA-CR-88212; TM-21) CFSTI: HC $3.00/MF $0.65 CSCL 20F

The optical requirements; and physical and performance characteristics of candidate camera systems are presented. Photo-optical, hybrid, electro-optical, and other systems are discussed. The relative merits of projected imaging systems are compared; and parametric relationships for acquisition optics are given. L.S.

N67-36116* Bell Aerosystems Co., Cleveland, Ohio.
STERILIZABLE ACCELEROMETER Quarterly Technical Report, Feb.–Apr. 1967
A. K. Hoffman and F. A. Petsock 22 Jun. 1967 73 p Prepared for JPL
(Contracts NAS7-100; JPL-951492)
(NASA-CR-88117; Rept.-60007-028; QTR-3) CSCL 14B

Work on the mechanical assembly was concentrated on the improvement of the bond from the springs to the pendulum supports and on evaluation of non-metallic sterilizable materials. Accelerometer M-225 was provided with Scotchcast EC-2258 in the spring joints. The experimentation program was not completed. Failure of Formex insulated magnet wire in the torquer coil required rebuilding of the accelerometer. Non-metallic materials under investigation, besides Formex insulation, were Epon 828 Z, Mystik tapes 7352 and 7300 and Kynar shrinkable tubing. Emphasis was placed on the pickoff electronics in the area of the bridge pickoff transformer. A study was conducted in the area of transformer parts such as core-tapes, wire, etc., to insure proper operation after temperature sterilization. Discrete components intended for use in the final electronic assemblies were selected. A complete design review of the electronic subassembly was conducted and is presented. Author

N67-36122* Heat Technology Lab., Inc., Huntsville, Ala.
DETERMINATION OF CAPTURE COEFFICIENT OF A HIGHLY DIRECTED FLOW OF GASEOUS CARBON DIOXIDE AND WATER VAPOR ON A LIQUID NITROGEN COOLED SURFACE Final Report
W. W. Youngblood 12 Dec. 1966 27 p refs
(Contract NAS8-20554)
(NASA-CR-88353; HTL-TR-36) CSCL 14B

A small, elementary continuum source molecular beam was designed and fabricated to provide a highly directed flow of gases for the experimental determination of the capture coefficient of gaseous carbon dioxide and water vapor. This prototype molecular beam has a theoretically predicted molecular flux of 1.99×10^{15} molecules/cm^{2}sec for gaseous carbon dioxide having a stagnation pressure of 500 Torr, stagnation temperature of 293°K, and a skimmer Mach number of 8.2. Author

N67-36124# Nationaal Lucht-en Ruimtevaartlaboratorium, Amsterdam (Netherlands). National Aerospace Lab.
REPORTS AND TRANSACTIONS, VOLUME XXXII [VERSLAGEN EN VERHANDELINGEN, XXXII]
1967 114 p refs
CFSTI: HC $3.00/MF $0.65

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N67-36125# Nationaal Lucht-en Ruimtevaartlaboratorium, Amsterdam (Netherlands). National Aerospace Lab.
THEORETICAL AND EXPERIMENTAL RESULTS FOR THE DYNAMIC RESPONSE OF PRESSURE MEASURING SYSTEMS
H. Bergh and H. Tijdeman *In its* Rept. and Trans., Vol. 32 1967 19 p refs (See N67-36124 21-14)
(NLR-TR-F.238)

For a series-connection of N thin tubes and N volumes a general recursion formula has been derived that relates the sinusoidal pressure disturbance in volume j to the pressure disturbances in the preceding volume j−1 and the next volume j+1. From this recursion formula the expressions for the complex ratio of the pressure fluctuation of each volume j to the sinusoidal input pressure p_o can be derived by successively putting j=N,N−1,...2,1. For a single pressure measuring system (N=1) and a double pressure measuring system (N=2) these dynamic response formulas are given explicitly. Theoretical results for single pressure measuring systems are presented that demonstrate the influence of the different parameters. As an illustrative example of the double pressure measuring system, some calculations have been performed for a system with a discontinuity in tube radius. Comparison of theoretical and experimental results shows that the response characteristics of the pressure measuring systems considered can be predicted theoretically to a high degree of accuracy. Author

N67-36126# Nationaal Lucht-en Ruimtevaartlaboratorium, Amsterdam (Netherlands). National Aerospace Lab.
A METHOD FOR ESTIMATING UNSTEADY PRESSURE DISTRIBUTIONS FOR ARBITRARY VIBRATION MODES FROM THEORY AND FROM MEASURED DISTRIBUTIONS FOR ONE SINGLE MODE
H. Bergh and R. J. Zwaan *In its* Rept. and Trans., Vol. 32 1967 16 p refs (See N67-36124 21-14)
(NLR-TR-F.250)

A method is proposed to estimate lifting surface pressure distributions for arbitrary vibration modes by theory and by measured distributions for one single mode. Its usefulness is demonstrated on two swept wings of small aspect ratio oscillating in incompressible flow. Due to insensitivity to reduced frequency variations of the correction procedure, it appears possible to predict experimental pressure distributions for reduced frequencies, more or less different from the values used in the measurements. Author

N67-36136# Sandia Corp., Albuquerque, N. Mex.
ON-BOARD SIGNAL CONDITIONING FOR PIEZOELECTRIC ACCELEROMETERS
H. D. Arlowe and G. W. Holmes May 1967 13 p Presented at 22nd Instr.-Automation Conf. and Exhibit, Chicago
(Contract AT(29-1)-789)
(SC-DC-67-1787) CFSTI: HC $3.00/MF $0.65

Some traditional and current problems involved in collecting data from hard wire accelerometer instrumentation are described. Design concepts and problems are covered which pertain to a suitable on-board high impedance line driver. Finally, a pulse width modulation technique is discussed which appears to overcome many of the current on-board instrumentation problems. Author (NSA)

N67-36153# Ministry of Technology, London (England). Aeronautical Research Council.
THE ACCURACY OF PRESSURE TRANSDUCERS WHEN USED IN SHORT-DURATION WIND-TUNNEL FACILITIES
L. Pennelegion, K. Wilson, and B. Redston HMSO, 1967 43 p refs Supersedes NPL-AERO-1213; ARC-26577
(ARC-CP-949; NPL-AERO-1213; ARC-26577) CFSTI: HC $3.00/MF $0.65

Calibrations have been made of some pressure transducers in the pressure ranges 0–20, 0–100, and 0–760 mm Hg. The pressure step was applied in a time of 2–3 ms. Standard deviations have been computed and are used for comparisons and for estimation of accuracies in a shock tunnel flow. A few measurements are presented of acceleration sensitivities. Author

N67-36167# ARO Inc., Arnold Air Force Station, Tenn.
A PORTABLE CALIBRATOR FOR INTERMEDIATE RANGE VACUUM GAGES
G. D. Arney, Jr. and W. F. Henderson Arnold Eng. Develop. Center, May 1967 17 p refs
(Contract AF 40(600)-1200)
(AEDC-TR-67-83; AD-654279)

A portable calibrator to facilitate 'in-place' calibrations of intermediate range pressure transducers has been developed. The operating principle of the calibrator is to transfer gas, in controllable mass increments, into an initially evacuated vessel of known volume by use of a transfer volume. By adjusting the mass increments to specific predetermined levels, the pressure in the initially evacuated vessel can be increased in steps of 0.001, 0.01, 0.1, or 1 torr. The pressure ranges covered are from 0.001 to 1 torr and from 1 to 30 torr. The indicated corresponding limits of error applicable to each range are plus or minus 1.3 and plus or minus 0.76 percent of desired pressure level, respectively. Author (TAB)

N67-36184# System Development Corp., Falls Church, Va.
INFLUENCE OF SCREENING AND OVERLAPPING IMAGERY ON SPEED AND ACCURACY OF PHOTO INTERPRETATION
Norman E. Willmorth and Abraham H. Birnbaum (Army Behavioral Sci., Res. Lab.) Washington, D. C., Army Behavioral, Sci. Res. Lab., Apr. 1967 41 p refs
(Contract DA-49-092-ARO-65)
(BESRL-TRN-82; AD-654347)

An evaluation was made of the separate screening of aerial photos prior to interpretation as a technique for improving performance in the quick-time extraction of information from imagery under varying conditions of frame overlap and image quality. Rolls of positive transparencies were interpreted by 48 interpreters under two conditions: In one condition, the photos had been screened by experienced interpreters; in the other, interpreters used normal Hot Report techniques combining frame selection and target identification in one process. Zero overlap and 50 percent overlap and two levels of image quality were represented in the imagery. On the first trial, half the subjects interpreted preselected imagery, half used regular techniques; on the second trial, procedures were reversed for the two groups. Interpreter performance was evaluated in terms of screening efficiency, accuracy and completeness of interpretation, time and rate of interpretation, and errors. The separate screening procedure added significantly to interpretation time. Overlapping imagery added significantly to interpretation time without increasing accuracy or completeness. The slight difference in image quality introduced did not seriously affect processing time. Accuracy of both screening and interpretation was lower with the lower quality imagery. Screening was more seriously affected than was interpretation. On the basis of evidence, screening cannot be recommended as a useful procedure in rapid interpretation. Author (TAB)

N67-36211*# Hughes Aircraft Co., Culver City, Calif.
SURVEYOR TELEVISION MECHANISMS
J. B. Gudikunst *In* JPL 2d Aerospace Mech. Symp. 15 Aug. 1967 p 59–66 (See N67-36203 21-31)

Details are given on the mirror assembly, the variable-focal-length lens assembly, the filter wheel assembly, and the focal-plane shutter assembly of the Surveyor spacecraft camera. Detailed design specifications for each component are presented, with particular emphasis on operating conditions in the lunar environment. Author

N67-36213*# Santa Barbara Research Center, Goleta, Calif.
MECHANICAL DESIGN OF SCANNING INSTRUMENTS
G. A. Bunson *In* JPL 2d Aerospace Mech. Symp. 15 Aug. 1967 p 77–84 (See N67-36203 21-31)
(Contract NAS1-3827)

The mechanical characteristics of the Surveyor Canopus sensor and the Project Scanner dual radiometer are representative of the types of optical mechanical instrument design that have been required for space applications. These instruments have performed successfully in space: one was a star-tracking guidance system utilizing the visible spectrum; the other was a research package for measurement in the infrared. Descriptive data are presented on the mechanical configurations and design solutions generated for these instruments which are, in general, applicable to similar instruments. Author

N67-36220*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
DOUBLE-ACTING, ROTARY-SOLENOID-ACTUATED SHUTTER
Allen G. Ford *In its* 2d Aerospace Mech. Symp. 15 Aug. 1967 p 131–138 (See N67-36203 21-31)

The development of a focal-plane shutter for use in the Surveyor spacecraft cameras is described. The shutter action is performed by two blades that are suspended on parallelogram linkages and driven by rotary solenoids. The solenoids utilize a permanent magnet rotor to provide magnetic latching and reversal of motion by reversal of current. Author

N67-36284# Institut Franco-Allemand de Recherches, St. Louis (France).
THE UTILIZATION OF THE HOLOGRAPH IN THE AREA OF AERODYNAMICS [ANWENDUNGEN DER HOLOGRAPHIE AUF DEM GEBIET DER AERODYNAMIK]
P. Smigielski and H. Royer 29 Sep. 1966 15 p refs In FRENCH Sponsored by Direc. des Rech. et Moyens d'Essais
(ISL-T-26/66) CFSTI: HC $3.00/MF $0.65

Relief pictures were obtained from an application of the holography technique in aerodynamics. In addition to the high quality, a cinehologram and an interferogram of gas flow in scattered light were obtained. Transl. by R.Li.

N67-36285# Israel Program for Scientific Translations, Ltd., Jerusalem.
HANDBOOK OF AUTOMATIC CONTROL INSTRUMENTS WITH ISOTOPE SOURCES
L. I. Korotkov 1966 208 p Transl. into ENGLISH of the book "Spravochnik po Radioizotopnym Priboram dlya Kontrolya i Avtomatizatsii Tekhnologicheskikh Protsessov" Moscow, Gosatomizdat, 1963
(AEC-TR-6633)

Presented is a handbook giving the technical characteristics and describing the principal nucleonic instruments used and being introduced by Soviet industry. Automatic control instruments with isotope sources are discussed for the purpose of aiding scientific and engineering technical workers who are trying to automate technological processes. R.Li.

N67-36300# Comitato Nazionale per l'Energia Nucleare, Rome (Italy).
MODIFICATION OF A 512 CHANNEL LABEN ANALYZER FOR HIGH-RESOLUTION MULTIDIMENSIONAL ANALYSIS [ELABORAZIONE DI UN ANALIZATORE LABEN A 512 CANALI PER ANALISI MULTIDIMENSIONALI AD ALTA RISOLUZIONE]
F. Castrica 1966 17 p In ITALIAN
(RT-EL-(66)-15)

The modification of a LABEN-A512 analyzer is described with the purpose to allow high resolution multiparameter analysis. Author (NSA)

N67-36459*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
CALIBRATION STANDARDS FOR PHOTO SPECTROSCOPY BETWEEN 20–200 KeV
Stephen S. Holt Sep. 1967 18 p refs
(NASA-TM-X-55912; X-611-67-433) CFSTI: HC $3.00/MF $0.65 CSCL 03A

Alkalie halide scintillator, gas proportional counter, and solid state crystal types of detectors used in space research for photons above 30 KeV are discussed. Calibration standards for photon spectroscopy between 20–200 KeV are presented. The study was conducted for determining the depth and dead layer of a Ge(Li) detector. It was found that the published relative intensities of lines from Cd^{109} and Ba^{133} could be consistently reconciled with a detector depth of 1 cm masked by a 30 micron dead layer. A source catalogue was compiled with this detector. L.S.

N67-36476# Massachusetts Inst. of Tech., Cambridge. Instrumentation Lab.
AN ANALYTICAL WINDAGE EXPRESSION FOR BALL-BEARING GYROSCOPE WHEELS. VOLUME I: CONTINUUM REGIME. VOLUME II: SLIP REGIME
Martin Roberts Nov. 1966 98 p refs
(Contract AF 33(615)-2243)
(E-2050, Vol. I; E-2050, Vol. II; AD-654691)

A study was made of the windage contributions of typical free surfaces and gaps found in the gyro wheel-motor-gimbal geometry with ball-bearing spin-axis support. A series of tests varying geometry and gas conditions was performed to verify the validity of the theoretical derivations. Correlation was generally better than 85%. The results are presented in graphical form to show comparison of theory and test results whenever possible. A constriction drag coefficient was derived to express the windage effect due to the close-fitting gimbal shell. A study was also made of the gas-surface slip effect that results in a considerable reduction in gyro wheel windage at low operating gas pressures. Exact mathematical derivations of the slip factors are presented for the four types of wheel surfaces: (1) Vertical gap between flat surfaces of wheel and motor, (2) outer face or side rim, (3) wheel OD, and (4) annular gap between wheel and motor. Test data are presented for windage measurements with helium from 5080 microns (.2 inches) Hg to 500 microns Hg. An empirical constriction drag coefficient is derived from the data for the narrow gap between wheel OD and float enclosure when operating in the slip flow regime. TAB

N67-36484# Institutt for Atomenergi, Kjeller (Norway).
ON THE USE OF SOLID STATE NUCLEAR TRACK DETECTORS IN REACTOR PHYSICS EXPERIMENTS
J. W. N. Tuyn Mar. 1966 17 p refs
(NORA-MEMO-123)

Some methods to replace counting of tracks, produced by fission fragments and α-particles in several detector materials are discussed. Results of preliminary measurements of fast neutron flux distributions are presented. Author

N67-36487# United Kingdom Atomic Energy Authority, Dounreay (Scotland). Experimental Reactor Establishment.
X-RAY DIFFRACTOMETRY TECHNIQUES FOR CERAMIC FUELS
W. B. Bremner and D. B. White 5 Aug. 1966 12 p refs
(TRG-1309(D)) CFSTI: HC $3.00/MF $0.65

The design of suitable diffractometer sample containment involving a nitrogen/argon two-gas system is described. Various mounting techniques are discussed and their relative merits are outlined. It was found that a resin mounting technique was most suitable for diffraction line profile measurements when (U Pu)O_2 was being examined. Analysis of small amounts of sesquicarbide and oxide phases in (U Pu)C was carried out using a paraffin wax binder, followed by low-pressure pelleting. Examples of the application of these and other diffractometry techniques are given. Author (NSA)

N67-36490*# IIT Research Inst., Chicago, Ill.
LIGHT SOURCES FOR REMOTE SENSING SYSTEMS
M. W. P. Cann Washington, NASA, Aug. 1967 162 p refs
(Contract NAS8-20107)
(NASA-CR-854) CFSTI: HC $3.00 CSCL 20F

The available light sources in the spectral range 150 to 2000 nm (nanometers) are reviewed. Attention is confined to sources which are either DC or operate at frequencies in excess of 1 MHz; the properties investigated are spectral intensity distribution, uniformity of emission over source area and emission angle, stability, and life. Some attention is given to light sources described in the literature where these fulfill a need not met by those available commercially. The report presents intercomparisons between different types of sources but generally not between sources of the same type from different manufacturers, although listings of the properties of the commercial sources are given. Author

N67-36499* Volt Technical Corp., Washington, D. C.
THRESHOLD SENSITIVITY OF ASTRONOMICAL TV DEVICES [POROGOVAYA CHUVSTVITEL 'NOST' ASTRONOMICHESKOY TELEVIZIONNOY SISTEMY]
E. S. Agapov, V. F. Anisimov, R. I. Kiladze, S. M. Sinenok, and A. Sh. Khatisov 12 Sep. 1967 6 p Transl. into ENGLISH from Byul. Abastumani. Astrofiz. Observ. (Tbilisi), no. 34, 1966 p 126–130
(Contract NAS5-12487)
(NASA-CR-88279; ST-ETC-OA-10645) CSCL 03A

The application of a television system in astronomy can considerably curtail the exposure time for obtaining images of weak stars using average-size instruments, by comparison with direct photographing. The experimental work for the determination of the penetration factor conducted at the Abastuman Observatory is described and comparison is made with the theoretical data. Author

N67-36505# Japan Atomic Energy Research Inst., Tokyo.
FABRICATION OF THICK GERMANIUM DETECTORS
Mitsuhiko Ishii, Tsutomu Tamura, Nsomota Shikazono, and Hidekuni Takekoshi Nov. 1966 12 p refs
(JAERI-1131)

Lithium-drifted germanium detectors of depletion depths up to 8 mm and diameter about 19 mm were fabricated from pulled, indium-doped, p-type single crystals. The detectors have an energy resolution of 4–5 keV (FWHM) for gamma rays from ^{60}Co, when used with a conventional low-noise preamplifier. The procedure for fabricating the thick germanium detectors is described in detail. Author (NSA)

N67-36532 Atomic Energy Centre, Lahore (Pakistan). Nuclear Physics Div.
SOLID STATE DETECTORS IN NUCLEAR PHYSICS
Naeem Ahmad Khan Apr. 1967 38 p refs
(PAECL/NP-6)

A brief comparative analysis of various types of solid state detectors is presented and their application in nuclear physics projects is discussed. For work requiring increased accuracy, two silicon surface barrier detectors, and one Ge(Li) detector were purchased. Briefly surveyed is the procedure for the preparation of different types of solid state detectors (namely surface barrier, diffused junction, and lithium ion-drifted detectors) both with silicon and germanium semi-conducting materials. Some experiments in nuclear physics are described in principle. R.U.

N67-36546# United Kingdom Atomic Energy Authority, Risley (England). Reactor Group.
METAL-SHEATHED MINERAL-INSULATED BASE-METAL THERMOCOUPLES
A. W. Fenton *In its* In-Pile Irradiation Equipment and Tech. 1967 p 43–48 refs (See N67-36541 21-22)

Error sources in sheathed Chromel/Alumel wires are discussed. Thermally-induced instabilities in the Chromel wire are shown to be the usual main cause of calibration drift. The effects of coolant penetrating the sheaths are described. Failure mechanisms together with some application and fabrication techniques are outlined. Author

N67-36557# Academia R. P. R., Bucharest. Institutul de Fizica Atomica.
CYCLOTRONIC MASS SPECTROMETER WITH NON-ACCELERATING SYNCHRONOUS ION
V. Mercea 1967 23 p refs
(IFA-IS-41)

An efficient operating mode of a cyclotronic mass spectrometer (synchrometer) with non-accelerating synchronous ions was theoretically investigated. NSA

N67-36577# Massachusetts Inst. of Tech., Cambridge.
INSTRUMENTATION LABORATORY
In its Res. in Mater. Sci. and Eng. Apr. 1967 p 357–373 refs (See N67-36571 21-26)

Materials research by the instrumentation laboratory is reported, including studies on organic encapsulating materials, moldable ceramics, high density and sprayed metals for gyro wheel rims, adhesives, and lubricants. Ball bearing retainer material is considered; as are the dimensional stability, steel cleanliness, structural alteration, and hardening of stainless steels used in ball bearing materials. Gas-bearing and Gas-lubricated gyro bearing materials development is reported; along with precision properties of gyro materials, gyro power leads, and gyro fluids. Dimensional stability of beryllium oxide, beryllium anodizing, liquid lubricants in vacuum environments, and materials in space environments are considered. M.W.R.

N67-36635*# Perkin-Elmer Corp., Norwalk, Conn. Optical Group.
SATURN LONG-RANGE AZIMUTH LAYING THEODOLITE Final Report
George J. Mrus 10 Mar. 1967 246 p
(Contract NAS8-11603)
(NASA-CR-88276; Rept.-8050) CSCL 17H

A long range theodolite that provides a solution to the problems inherent in azimuth laying of large space vehicles is described. This system simultaneously but separately monitors the alignment of two vehicle mounted prisms and tracks a sway prism located on the vehicle at operating distances up to 1000 feet. Television camera displays and simple switching controls permit completely automatic, remote controlled operation. Six systems were delivered for use on the Saturn program. Author

N67-36671# Royal Aircraft Establishment, Farnborough (England).
SUN AND HORIZON ATTITUDE SENSORS
M. B. Barnes *In* ESRO Control and Stabilization of Spacecraft. Vol. III: Active Control Systems Jan. 1967 p 35–59 refs (See N67-36669 21-31)

The design of sun and horizon sensors which may be used in an attitude control system of a space vehicle is described. A brief outline of the techniques employed is given. Author (ESRO)

N67-36672# Royal Aircraft Establishment, Farnborough (England).
STAR SENSORS
P. Haskell *In* ESRO Control and Stabilization of Spacecraft. Vol. III: Active Control Systems Jan. 1967 p 61–88 refs (See N67-36669 21-31)

Discussion centers on the basic principles governing the choice of detectors and the design of star sensors which may be used to derive misalignment error signals in a closed-loop feedback system stabilizing the attitude of a satellite in space axes. A frequency-modulated star sensor is described, and details of its performance in the laboratory and field are given. A description of two of the many star trackers in existence is given with such details of their performance as are available in the published literature. Author (ESRO)

N67-36676# Royal Aircraft Establishment, Farnborough (England).
REACTION WHEELS AND GYROS
J. K. Abbott *In* ESRO Control and Stabilization of Spacecraft. Vol. III: Active Control Systems Jan. 1967 p 155–170 (See N67-36669 21-31)

The characteristics and design criteria of the two types of momentum exchange actuator, namely reaction wheels and a special type of gyroscope, are discussed and analyzed. The equations of motion for reaction wheels are first derived, followed by a discussion of their required characteristics and the types of motor which may be used. Reliability of reaction wheels is discussed and its importance stressed. The special type of gyroscope is then examined, equations of motion and a note on power consumption being given. Gyroscopes used in the more usual way as attitude and rate sensors are briefly discussed, and then the special characteristics required for use in space are considered. Author (ESRO)

N67-36677# Royal Aircraft Establishment, Farnborough (England).
REACTION WHEEL CONTROL SYSTEMS
J. K. Abbott *In* ESRO Control and Stabilization of Spacecraft. Vol. III: Active Control Systems Jan. 1967 p 171–185 refs (See N67-36669 21-31)

The advantages of momentum exchange actuators over jet actuators are first stated. Both linear and nonlinear systems using reaction wheels are analyzed in some detail and methods of stabilization are discussed. A description is given of systems which use gyroscopes as momentum exchange actuators. Author (ESRO)

15 MACHINE ELEMENTS AND PROCESSES

Includes bearings, seals, pumps, and other mechanical equipment; lubrication, friction, and wear; manufacturing processes and quality control, and reliability; drafting; and materials fabrication, handling, and inspection.

N67-35303*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
AEROSPACE RELATED TECHNOLOGY CONFERENCE FOR INDUSTRY AND COMMERCE
Washington, NASA, 25 May 1967 90 p
(NASA-TM-X-52345) CSCL 13H

CONTENTS:

1. MATERIALS H. Allen, Jr. p 1–15 (See N67-35304 21-18)
2. FABRICATION AND PROCESSING P. Sirocky p 17–34 (See N67-35305 21-15)
3. MECHANICAL EQUIPMENT, BEARINGS, AND LUBRICATION J. E. Burnett p 35–52 (See N67-35306 21-15)
4. ELECTRICAL, ELECTRONIC, AND FLUID DEVICES D. J. Vargo p 63–68 (See N67-35307 21-09)
5. BIOTECHNOLOGY P. Foster p 69–85 (See N67-35308 21-05)

N67-35305*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
FABRICATION AND PROCESSING
Paul Sirocky *In its* Aerospace Related Technol. Conf. for Ind. and Com. 25 May 1967 p 17–34 (See N67-35303 21-15)

Methods of forming, joining, and machining that were developed for aerospace needs and that may have application for more conventional industries are described. Metal forming processes reviewed are pneumatic-mechanical using high pressure gas, explosive, electrospark, electro-magnetic, and magnetic hammer methods. Electron beam welding and a laser melting and evaporating process for joining are summarized. The chief advantage of electric discharge and electrochemical machining, and chemical milling is considered to be the ease with which most resistant materials can be formed into shapes not possible with conventional processes. N.E.N.

N67-35306*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
MECHANICAL EQUIPMENT, BEARINGS, AND LUBRICATION
James E. Burnett *In its* Aerospace Related Technol. Conf. for Ind. and Com. 25 May 1967 p 35-52 (See N67-35303 21-15)

Bearing and lubrication technology for smaller, lighter, higher performance equipment, especially for high speed rotating machinery in hard vacuum, is briefly discussed. Ways of increasing life-expectancy of bearings and the influence of atomic structure on friction and wear properties are described. Both gas bearings and dry or solid lubricants are considered. A loss of steering control noticed by aircraft pilots on wet runways was investigated and found to be due to a hydroplaning effect. The low friction of fiberglass reinforced teflon, and other applications for rotating machinery are mentioned. N.E.N.

N67-35338* United Technology Center, Sunnyvale, Calif.
COMPARISON OF SOME RELIABILITY GROWTH ESTIMATION AND PREDICTION SCHEMES
W. J. Corcoran and R. R. Read 1 Jun. 1967 51 p refs
(Contract NAS7-356)
(NASA-CR-87993; UTC-2140-ITR-Addend.) CSCL 14D

Questions of predicting the growth of reliability and the development of simulation models are discussed. Many reliability growth models provide only mathematical expression for growth without any associated scheme for estimating the model parameters from some form of failure data. Various statistical estimation methods could apply generally to such models. Problem areas are identified and it is concluded that the major problem is the selection of a measure of effectiveness. Results of pilot experimentation performed on a computer using several common measures are evaluated. S.P.

N67-35384*# Mechanical Technology, Inc., Latham, N. Y.
RESEARCH AND DEVELOPMENT OF HIGH-PERFORMANCE AXIAL-FLOW TURBOMACHINERY. VOLUME 2: DESIGN OF GAS BEARINGS
P. W. Curwen Jun. 1967 498 p refs Prepared for Pratt and Whitney Aircraft
(Contract NAS3-4179)
(NASA-CR-801; PWA-2977, Vol. 2; MTI-67TR9) CSCL 13I

Three variations of a basic gas-bearing rotor-support system have been designed, built, and tested for the NASA Brayton cycle axial-flow turbocompressor. The designs were experimentally evaluated in a full-scale rotor-bearing system test rig. All three bearing system designs performed satisfactorily and successfully passed the required P&WA acceptance tests. The final design represents a minimum bearing-friction-loss design consistent with whirl-free operation of the rotor. Following acceptance testing of the first, or initial, gas-bearing rotor-support system, an attempt was made to attain a 61 percent reduction in total journal bearing friction loss by modifying the bearings to operate at larger clearances. Upon test of the modified design, a low-frequency, stable, rotor-whirl phenomenon was observed in the turbine bearing as the clearance was being increased to the larger value. Until the whirl phenomenon is better understood, MTI recommends that the diametral clearances of the journal bearings be maintanined less-than-or-equal-to 0.00135 inches. This will assure whirl-free operation of the rotor. At these clearances, the final design represents a 34.3 percent reduction in total journal bearing friction loss relative to the initial design. Author

N67-35390# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
MOMENTS ORIGINATING FROM ERRORS IN THE FORM OF ROLLING SURFACES OF A BALL BEARING [MOMENTY, VOZNIKAYUSHCHIYE OT POGRESHNOSTI FORMY POVERKHNOSTEY KACHENIYA SHARIKOPODSHIPNIKA]
Ye. M. Rodionov 23 Dec. 1966 30 p refs Transl. into ENGLISH from Aviats. Tekhnol. Inst. Tr. "Tekhnol. i Konstruirovaniye Giropriborov" (Moscow), 1964 p 54-73
(FTD-HT-66-374; TT-67-62283; AD-655030)

The paper proposes, in a general form, a method for determining the translational displacements and additional moments of friction affecting rotation in ball bearings which are produced by translational motion (in addition to the vibration of fast moving shafts) of the rotating ring due to defects in the shape of the rolling surfaces of rings and balls as well as to the presence of a radial clearance, a bearing stiffness which varies with the angle of rotation, and other causes. These additional moments resisting the rotation of a ball bearing vary with the angle of rotation and, in contrast to the moments due to frictional forces, do not change their sign when reversing the bearing motion and do not decrease with vibration. The magnitude and character of the variation in these moments with the angle of rotation is closely related to the initial relative position of bearing parts as well as to the positions of balls as a result of vibration, clogging up, etc., and therefore these moments change when the relative position of the rings changes. The instability of the additional moments causes random errors in instruments, and unstable drift of gyroscopes which cannot be eliminated by balancing or correction. The translational displacements of the rotating ring and the additional moments are examined analytically for the case of an actual ball bearing. TAB

N67-35444 Glacier Metal Co., Ltd., Wembley (England).
THE DESIGN AND APPLICATION OF PLAIN BEARINGS FOR POWER TRANSMISSION MACHINERY
S. O. Rafique [1966] 20 p refs Presented at the B.G.M.A. Meeting, Coventry, 1 Nov. 1966

Basic considerations in bearing design are defined to show the limitations on the design specialist's capabilities, and the need for the power transmission engineer to delineate his requirements. It is pointed out that these areas of interaction pertain to the materials in contact with, or in close proximity to, the bearing such as the shaft, housing, and lubricant; to the steady or transient environment; and to the location and wall thickness of shells. Principles regarding bearing operations as they affect the user are enumerated for hydrodynamic lubrication, boundary lubrication, marine power transmission, electric motors and generators, rolling mill gear boxes, automotive gear boxes, and shaft linings and placements. M.G.J.

N67-35459 General Electric Co., Philadelphia, Pa.
MANUFACTURING PROCESSES FOR FABRICATION OF LARGE TITANIUM STRUCTURES
E. B. Cooper and J. Daugherty Aug. 1966 78 p
(R66FPD201)

A weldability study, a formability study, and the fabrication of a 48" diameter, Ti 5Al-2-1/2Sn front frame, which simulated the design characteristics of a planned advanced engine, are presented. It was concluded that: (1) Ti 5Al-2-1/2Sn alloy is a suitable material for complex fabrications. (2) Hot forming is a feasible process for low cost parts. (3) Electron beam welding is a practical welding process. (4) Proper cleaning must be accomplished and harmful contaminants avoided during thermal cycles. (5) Good atmospheric protection must be provided during welding and thermal cycles. (6) Distortion and stresses can be minimized by proper processing. Author

N67-35461*# Chrysler Corp., New Orleans, La. Space Div.
TEST REPORT FOR RELIEF VALVE, 1- BY 2-INCH, 300-PSIG ANDERSON GREENWOOD PART NUMBER 2510D12/8 MODIFIED
27 Mar. 1967 56 p
(Contract NAS8-4016)
(NASA-CR-88017; TR-RE-CCSD-FO-1104-3) CSCL 13K

Results of operational requirements testing are given for a relief valve, which is used to relieve overpressure in the liquid oxygen recycle line at Launch Complex 34. Tests performed included: proof pressure, functional, flow, surge, high temperature, cycle, and burst. All test results are considered satisfactory. E.C.

N67-35476 Joint Publications Research Service, Washington, D. C.
MANUFACTURING OF PARABOLOID AREA COLLECTORS BY ROTATION
G. Ya. Umarov, A. K. Alimov, F. N. Suleymanova, and D. N. Alauutdinov *In its* Res. in Solar Eng. 24 May 1967 p 38–41 refs (See N67-35470 21-03)

The technology of copies manufactured from 1.2-mm diameter matrices is considered. Epoxy resins are used for preparation of matrices. It is shown that manufacturing of large solar collectors from matrices by the rotation method is feasible. Author

N67-35554*# Mechanical Technology, Inc., Latham, N. Y.
PERFORMANCE CHARACTERISTICS OF HERRINGBONE-GROOVED JOURNAL BEARINGS OPERATING AT HIGH ECCENTRICITY RATIOS AND WITH MISALIGNMENT
V. Castelli and J. H. Vohr Mar. 1967 39 p refs Sponsored in part by NASA
(Contract Nonr-3730(00))
(NASA-CR-88085; MTI-67TR15; AD-654580) CSCL 13I

The differential equation for the pressure distribution around a spiral-grooved journal bearing with compressible lubricant is solved by the numerical method of matrix influence coefficients for the case of arbitrary eccentricity and misalignment. Performance characteristics are presented for one particular bearing over the range 0 Lambda 20. Results are presented showing the restoring moment due to misalignment, the effect of L/D ratio at large eccentricity and the influence of eccentricity ratio on the optimum values of groove parameters for maximum radial stiffness. Comparison is made with experimental results. Author (TAB)

N67-35568*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
CONFERENCE ON DESIGN OF LEAK-TIGHT SEPARABLE FLUID CONNECTORS, VOLUME I
25 Mar. 1964 340 p refs Proc. held 24–25 Mar. 1964
(NASA-TM-X-60234) CSCL 13K

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3. THE PROBLEM OF STATING THE TUBE CONNECTOR PROBLEM K. Bragg (Parker Aircraft Co.) p 45–62 (See N67-35571 21-15)

4. FIVE REGIMES OF METAL-TO-METAL SEALING F. O. Rathburn, Jr. (GE) p 63–88 refs (See N67-35572 21-15)

5. SIGNIFICANT FACTORS IN THE DESIGN AND CLASSIFICATION OF SEPARABLE TUBE CONNECTORS E. C. Rodabaugh (Battelle Mem. Inst.) p 89–122 refs (See N67-35573 21-15)

6. ELASTIC DISPLACEMENTS IN THE DESIGN OF THREADED TUBE CONNECTORS J. W. Adam (Battelle Mem. Inst.) p 123–156 refs (See N67-35574 21-15)

7. HELIUM LEAK-TIGHT SEAL FUNCTIONAL ANALYSIS AND DEVELOPMENT B. Goobich (Battelle Mem. Inst.) p 157–192 refs (See N67-35575 21-15)

8. RECENT DEVELOPMENTS OF INSTRUMENTATION AND MEASUREMENT FOR EVALUATING SEPARABLE TUBING CONNECTOR AND MANUFACTURING TOOLING W. B. Cruise and J. R. Rasquin p 193–212 (See N67-35576 21-15)

9. LABORATORY LEAKAGE MEASUREMENT TECHNIQUES ON SEPARABLE CONNECTORS L. E. Grimes (Gen. Dyn.) p 213–244 refs (See N67-35577 21-15)

10. LEAKAGE MEASUREMENT AND EVALUATION J. W. Marr (Gen. Elec.) p 245–306 refs (See N67-35578 21-15)

11. ACOUSTIC RADIATION DAMAGE IN MATERIALS B. Langenecker (Naval Ordnance Test Sta.) p 307–326 refs (See N67-35579 21-15)

12. OPTICAL OBSERVATIONS OF SEALING PHENOMENON L. G. Gitzedanner (GE) p 327–344 (See N67-35580 21-15)

N67-35569*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
ZERO LEAKAGE EFFORT FOR SATURN VEHICLES
Herbert Bergeler *In its* Conf. on Design of Leak-Tight Separable Fluid Connectors, Vol. 1 25 Mar. 1964 p 3–28 (See N67-35568 21-15)

In application to launchings of missiles, rockets and space vehicles, statistical data are presented on monitoring zero-leakage test programs for Saturn I, IB and V. Slides show tube connections used on the different stages of the Saturn vehicle, and the propulsion system broken down according to working fluids. A compilation of all seals and connections in the vehicle systems for monitoring the zero-leakage program is presented and includes measuring leakage on flange seals during bench, system, acceptance, static firing, and flight tests. R.Li.

N67-35570*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
STATISTICAL EVALUATION OF FLARE DIMENSIONS OBTAINABLE WITH CURRENT MANUFACTURING PROCESSES
R. D. Blakley (Chrysler Corp., New Orleans, La.) *In its* Conf. on Design of Leak-Tight Separable Fluid Connectors, Vol. 1 25 Mar. 1964 p 29–44 (See N67-35568 21-15)

In connection with tube flaring operation, a sampling program and results from a three-month period of operation are reported. Flaring equipment and inspection methods are outlined briefly. Inspection data is then analyzed from two points of view. Inspected samples charted show the overall operating condition which includes initial set-up and subsequent set-up adjustments when the initial set-up was out of tolerance. Graphs, averages, and control limits derived from this data are included. R.Li.

N67-35571*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
THE PROBLEM OF STATING THE TUBE CONNECTOR PROBLEM
Ken Bragg (Parker Aircraft Co.) *In its* Conf. on Design of Leak-Tight Separable Fluid Connectors, Vol. 1 25 Mar. 1964 p 45–62 (See N67-35568 21-15)

The problem of zero leakage for tube connectors in spacecraft is highlighted. Cited is the need to minimize the number of connector types because each additional type reduces reliability and increases cost. The improper application of connectors prevent their proper functioning. Another cost factor increase is due to additional training required because more errors need to be corrected and more stocking and handling is required. For reduced connector types, excess weight requirements are inevitable. Definitions are provided for three classifications of connectors: permanent, semi-permanent, and separable. It is considered that the process of developing a new connector concept should be an iterative process

where the problem statement affects the concept and as the concept develops, it affects the problem statement. With this interchange taking place in smaller and smaller circles, the ultimate in optimization can be reached. R.Ll.

N67-35572*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
FIVE REGIMES OF METAL-TO-METAL SEALING
F. O. Rathburn, Jr. (Gen. Elec. Co., Schenectady, N. Y.) *In its* Conf. on Design of Leak-Tight Separable Fluid Connectors, Vol. 1 25 Mar. 1964 p 63–88 refs (See N67-35568 21-15)

The problem of maintaining a leakage seal, depending on the degree of mating between the sealing surfaces during the operational life of the seal, is briefly outlined. In separable connectors the barrier to leakage flow, usually consisting of flange faces, gaskets, or knife edges, requires an adequate force or stress between the sealing surfaces to insure that no leakage flow passes through the interface. Experimental results indicate that complete mating of contact surfaces is virtually impossible between flat surfaces mated together under normal stress as long as surface asperities exist on either or both surfaces. Once a certain amount of contact is made between surfaces, the local surface stress distribution tends to preclude further mating and the path of least resistance to further deformation is deformation in bulk of the softer body. It was also seen that pure area of contact evaluation is not suitable as a criterion for sealing. R.Ll.

N67-35573*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
SIGNIFICANT FACTORS IN THE DESIGN AND CLASSIFICATION OF SEPARABLE TUBE CONNECTORS
Everett C. Rodabaugh (Battelle Mem. Inst., Columbus, Ohio) *In its* Conf. on Design of Leak-Tight Separable Fluid Connectors, Vol. 1 25 Mar. 1964 p 89–122 refs (See N67-35568 21-15)

Technical data are presented on the design of separable tube connectors. Some significant factors of design considered are: seal seating load, structural loads, preload, reduction of load capacity at elevated temperatures, design requirements for restricted access assembly and disassembly, and materials available for minimum weight with adequate reliability. Several guidelines for the establishment of classes of separable connectors are suggested by these design factors: (1) For small-size connectors, relatively few pressure classes (3000 psi, 6000 psi, and 10,000 psi) can be used. (2) Threaded connectors can be used without excessive assembly torque requirements for small sizes. (3) For large-size connectors, the weight penalty in designing for pressures in excess of actual operating pressures is large. (4) The significant dependence of the load capacity of a connector at high temperatures on time, temperature, and material properties suggests that pressure ratings and corresponding moment capacities might be established as functions of these parameters. R.Ll.

N67-35574*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
ELASTIC DISPLACEMENTS IN THE DESIGN OF THREADED TUBE CONNECTORS
James W. Adam (Battelle Mem. Inst., Columbus, Ohio) *In its* Conf. on Design of Leak-Tight Separable Fluid Connectors, Vol. 1 25 Mar. 1964 p 123–156 refs (See N67-35568 21-15)

Consideration is given to threaded connectors designed on the basis of stress and elastic displacements. An analysis procedure utilizing a modified preload diagram is briefly outlined in connection with repetitive application of elastic displacement. The following characteristics are required for a satisfactory tube connector: (1) The preload established by construction of the modified preload diagram must be larger than the required initial seal seating load. (2) The actual nut deflection rate must be greater than or equal to the desired nut deflection rate as established by the modified preload diagram constructions. A specific preload variation may be designed by a judicious choice of the actual deflection rate. R.Ll.

N67-35575*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
HELIUM LEAK-TIGHT SEAL FUNCTIONAL ANALYSIS AND DEVELOPMENT
Bernard Goobich (Battelle Mem. Inst., Columbus, Ohio) *In its* Conf. on Design of Leak-Tight Separable Fluid Connectors, Vol. 1 25 Mar. 1964 p 157–192 refs (See N67-35568 21-15)

The need was established for a helium leak-tight seal which would seal helium pressurized at 2000 psi at temperatures ranging from −425 to 1500°F with a leakage rate no greater than 7.7×10^{-7} atm cc/sec. For this purpose a functional model was created and reduced into the bobbin seal design. The bobbin seal design was experimentally verified. R.Ll.

N67-35576*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
RECENT DEVELOPMENTS OF INSTRUMENTATION AND MEASUREMENT FOR EVALUATING SEPARABLE TUBING CONNECTOR AND MANUFACTURING TOOLING
W. B. Cruise and John R. Rasquin *In its* Conf. on Design of Leak-Tight Separable Fluid Connectors, Vol. 1 25 Mar. 1964 p 193–212 (See N67-35568 21-15)

Instrument measurements were used to identify the causes of leakage in pneumatic and hydraulic lines of tube connectors. The standard type of flared tube connector consisted of four parts: B-nut, sleeve, flared tube, and threaded fitting such as a union, or elbow. The problem of sealing a mechanical joint of this type is required by the increasing demands of spacecraft designs calling for the containment and transfer of light gases at high pressures and extreme high and low temperatures. The tests conducted are outlined, and some of the scientific equipment is depicted. R.Ll.

N67-35577*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
LABORATORY LEAKAGE MEASUREMENT TECHNIQUES ON SEPARABLE CONNECTORS
Larry E. Grimes (Gen. Dyn., San Diego, Calif.) *In its* Conf. on Design of Leak-Tight Separable Fluid Connectors, Vol. 1 25 Mar. 1964 p 213–244 refs (See N67-35568 21-15)

In application to high energy propellants for ICBM and space vehicles, leak detection on separable tube connectors was conducted. For measuring leaks, the following instruments were used in physical observation: sonic detector, bubble testing by soap solution, bubble testing by immersion, and leak detection by inclosing the connector. Leak detection by pressure variation is also mentioned. Designed for determining leakage rates in hydraulic power systems, a Delta-Vee model is depicted. When this is installed in the power line to the component being tested, leakage can be measured by the displacement of the separation level. Also included is a brief discussion of the previously mentioned leak detection methods, with respect to the problems encountered when dealing with cryogenic systems. R.Ll.

N67-35578*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
LEAKAGE MEASUREMENT AND EVALUATION
J. W. Marr (Gen. Elec. Co., Schenectady, N. Y.) *In its* Conf. on Design of Leak-Tight Separable Fluid Connectors, Vol. 1 25 Mar. 1964 p 245–306 refs (See N67-35568 21-15)

In order to establish rational tube leakage specification, an attempt was made to define the measurability of leakage rates and to establish conversion criteria between the leak rates measured with a tracer gas during testing and those produced by the working fluid at the operating pressure. Calculations are presented on the technique of converting the leakage of the test gas to the leakage during operation. Several pertinent conclusions and recommendations for future work are also presented. R.Ll.

N67-35579*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
ACOUSTIC RADIATION DAMAGE IN MATERIALS
B. Langenecker (Naval Ordnance Test Sta., China Lake, Calif.) *In its* Conf. on Design of Leak-Tight Separable Fluid Connectors, Vol. 1 25 Mar. 1964 p 307–326 refs (See N67-35568 21-15)

In connection with leak-tight separable fluid connectors, results from basic research on effects of intense ultrasound on physical properties of metals are summarized. In this general description, the marked reduction in the static yield stress of metals and plastics when exposed to sound waves is highlighted. It is shown how acoustic stress waves at frequencies between zero and 10^9 cycles per second may significantly reduce the static loading capacity, and may even cause severe damage of solids. R.Ll.

N67-35580*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
OPTICAL OBSERVATIONS OF SEALING PHENOMENON
L. G. Gitzedanner (Gen. Elec. Co., Schenectady, N. Y.) *In its* Conf. on Design of Leak-Tight Separable Fluid Connectors, Vol. 1 25 Mar. 1964 p 327–344 (See N67-35568 21-15)

A technical description is provided on an idealized system in which simultaneous measurements can be made of the leak rate and the leakage paths, which change according to fluctuations in load or gas pressure. In relation to a study of sealing phenomena, the optical test equipment is depicted and shows the mating surfaces to be studied (i.e., glass block and a seal ring or washer). Some results of experiments are presented along with other observations concerning the behavior of seals, for use in predicting reliability of sealing systems. R.Ll.

N67-35628*# Philco Corp., Blue Bell, Pa. Microelectronics Div.
DEVELOPMENT OF GLASS PASSIVATION METHOD FOR SEMICONDUCTOR DEVICES FOR SATURN SYSTEM Quarterly Progress Report, 28 Jun.–28 Sep. 1966
28 Sep. 1966 69 p
(Contract NAS8-18048)
(NASA-CR-88194; QPR-1) CFSTI: HC $3.00/MF $0.65 CSCL 13H

Glass deposition is described, with emphasis on deposition temperature, continuous coating of a nonplanar surface, charge content, deposition effects on planar devices, material etchability, and pinhole density caused by processing and deposition. A wafer plating process with a substrate temperature of 400°C appears to be the most compatible technique. Stressed was vapor plating using silane and involving oxidation. Vapor plated SiO_2 was found to have a charge concentration equal to good thermally grown oxides. MOS and bipolar devices encapsulated with this material performed well. The deposited material has a low pinhole density but is sensitive to wafer surface topography. The etch rate of the deposited glass was studied to find means of delineating openings through which leads may be attached. The mechanical and chemical protection afforded by the glass coating was evaluated. In a design study, a model was considered which consisted of a standard processed RTL wafer with special metallization to make available, individually, the discrete components. Tests with bipolar devices suggest that significant stability is already present. Other tests indicated changes resulting from charge accumulation on the surface of the oxide due to the voltages applied to the various conductors. K.W.

N67-35702*# Ampex Corp., Redwood City, Calif.
THE PROPAGATION OF DISTURBANCES IN THE INFINITELY WIDE FOIL BEARING
A. Eshel May 1967 29 p refs Sponsored in part by NASA
(Contract Nonr-3815(00)(X))
(NASA-CR-86780; RR-67-13; AD-654208) CSCL 13I

A technique for the solution of time dependent foil bearing problems is presented. Solutions obtained for typical disturbances which are introduced into the bearing, indicate that they are swept out at a speed of, essentially, U/2. The effects of higher foil stiffness on this phenomenon are found to be small. Author (TAB)

N67-35724# Air Force Systems Command, Wright-Patterson AFB, Ohio. Air Force Materials Lab.
A METHOD FOR DETERMINING ACTIVATION ENERGIES OF MICROCREEP IN FILAMENTS FROM FORCE-ELONGATION DATA Technical Report, Oct. 1963–Oct. 1966
Pierce M. Williamson May 1967 49 p refs
(AFML-TR-67-66; AD-654677)

A new method is demonstrated for determining activation energies of microcreep in polymeric filaments. The total activation energy is presented in a generalized form of the Arrhenius rate equation, k = A exp (- delta H/RT - delta F/w), which includes both heat of activation, delta H, and free energy of activation delta F. Force-elongation data, which are used to evaluate delta H and delta F, are obtained with a constant elongation rate machine capable of elongating a filament as slowly as 0.1 micron per minute and of measuring force through the filament from 1 to 980 dynes. The polymer used is polystyrene of 45,000 molecular weight. The filament is of 0.018 cm diameter formed by melt extrusion without drawing of thermal decomposition. The value of delta H found is 6,000 cal/gm-mol and delta F is 5,000 cal/gm-mol. Author (TAB)

N67-35747*# Lockheed-Georgia Co., Marietta. Proficiency Development Lab.
THE APPLICATION OF LIQUID CRYSTALS FOR THERMOGRAPHIC TESTING OF BONDED STRUCTURES
Sherman E. Cohen [1966] 55 p refs
(Contract NAS8-20627)
(NASA-CR-88196; PDL-7) CFSTI: HC $3.00/MF $0.65 CSCL 13H

This report describes the equipment and procedures developed for applying, testing, and photographically recording the results of thermographic tests using a liquid crystal heat sensitive coating that changes color with minute temperature gradients, caused by discontinuities, in the substrate structure. Bonded honeycomb and laminated metallic and non-metallic structural panels were tested in an analysis of technique capability. Special instrumentation was developed for a simple method of quantitatively evaluating liquid crystal mixtures. The data acquired is presented in tabular form and describes the type and size of flaws that can be detected with the portable nondestructive thermal analysis equipment. The technique was proven to be feasible in applications that would otherwise require more complex and costly infrared systems. Author

N67-35751*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
PRELIMINARY DETERMINATIONS OF TEMPERATURE LIMITATIONS OF ESTER, ETHER, AND HYDROCARBON BASE LUBRICANTS IN 25-MM BORE BALL BEARINGS
Erwin V. Zaretsky and William J. Anderson Washington, NASA, Sep. 1967 23 p refs
(NASA-TN-D-4146) CFSTI: HC $3.00/MF $0.65 CSCL 13I

Groups of 7205-size (25-mm bore) angular-contact ball bearings made from AISI M-1 steel were tested with eleven high-temperature lubricants. These lubricants were classified as polyphenyl ethers, esters, and hydrocarbons. Test conditions included outer-race temperatures of 250° to 600°F, speeds from 20,000 to 45,000 rpm, and maximum Hertz stresses of 189,000 to 347,000 psi in an SKF high-temperature bearing tester. Bearing AFBMA-rated (catalog) life was exceeded between 550° and 600°F with a synthetic paraffinic oil with an anti-wear additive under a low oxygen environment. The estimated bearing life with a diester base lubricant was less than half bearing AFBMA-rated (catalog) life in the temperature range of 450° and 550°F. The polyphenyl ethers exhibited the poorest life potential. Early fatigue spalling, wear, and surface distress occurred in the rolling-element components. The bearings run with the polyphenyl ethers did operate in an air environment; however, sludge formations occurred in both air and limited oxygen environments. Heavy coke deposits formed on bearings run with the ester lubricants at 500°F in a low oxygen environment. Gross lubricant degradation did not occur with the hydrocarbon lubricants run at 600°F in the low oxygen environment, although the fluid became blackened and some sludge deposits were noticed. Author

N67-35849# Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.

NONDESTRUCTIVE FLAW DETECTION BY USE OF ACOUSTIC EMISSIONS

D. L. Parry May 1967 44 p refs

(Contract AT(10-1)-205)

(IDO-17230) CFSTI: HC $3.00/MF $0.65

A requirement exists for a safeguards system that will ensure the integrity of the primary loop of a nuclear power installation. To meet this requirement, a technique of detecting the acoustic emissions of materials under stress has been applied as a non-destructive diagnostics tool for reactor pressure vessel and primary loop flaw analysis. The presence of a flaw in a metal under stress is evidenced by the low threshold of appearance for the acoustic signals, by an occurrence of burst signals, and by the increase in the continuous-emission-signal intensity with applied stress. Investigations into the feasibility of applying the acoustics phenomena as a safeguards system for ensuring primary loop integrity are being conducted as a test program. This test program has been developed around large-scale, complex reactor vessel testing, supplemented by laboratory-scale tensile-specimen testing. Author (NSA)

N67-35852# California Univ., Livermore. Lawrence Radiation Lab.

CENTRAL STATION APPLICATION OF GRAPHITE HELICAL ROTOR EXPANDERS

W. M. Wells 28 Apr. 1967 35 p refs Presented at the 2d Intersoc. Energy Conversion Eng. Conf., Miami Beach, Fla., 13–17 Aug. 1967

(Contract W-7405-ENG-48)

(UCRL-70258; CONF-670806-2) CFSTI: HC $3.00/MF $0.65

A preliminary examination is made of utilizing graphite helical rotor expanders in central station cycles similar to those proposed for inert gas nuclear MHD cycles. It is indicated that thermodynamic cycle efficiency will be better than for the MHD cycles. Graphite is currently available in the correct size range and with adequate mechanical properties. Gas bearings are indicated to be feasible for the application to central stations. Author (NSA)

N67-35902* Chrysler Corp., New Orleans, La. Space Div.

ANACONDA METAL FLEX HOSE VACUUM JACKETED 1-INCH I.D. BY 6 FT. LONG

R. A. Fee 1 Apr. 1967 44 p

(Contract NAS8-4016)

(NASA-CR-88273; TR-RE-CCSD-FO-1082-3) CSCL 13K

Results of the following tests performed on a metal flex hose are presented: proof pressure, functional, cycle, flow, high temperature, and burst. The test specimen failed to meet requirements during the burst test. The outer vacuum jacket wall at each end connection collapsed at a pressure of 2200 psig. The specified burst pressure was 3800 psig. The test specimen met all other requirements. Author

N67-35987* Chrysler Corp., New Orleans, La. Space Div.

CALIBRATION VALVE, 1/4-INCH, 6000-PSIG, SAGE ENGINEERING AND VALVE CO. DRAWING NUMBER 2-9064C WITH PROBE DRAWING NUMBER 2-8074, NASA DRAWING NUMBER 75M09618 PCVA-1 Test Report

Thomas C. Mahony 24 Apr. 1967 65 p

(Contract NAS8-4016)

(NASA-CR-87999; TR-RE-CCSD-FO-1108-3) CSCL 13K

This report presents the results of tests performed on one specimen of the Calibration Valve 75M09618 PCVA-1 and Probe 75M07278. The following tests were performed: (1) Receiving Inspection; (2) Proof Pressure; (3) Functional; (4) Low Temperature; (5) High Temperature; (6) Surge; (7) Salt Fog; (8) Cycle; (9) Burst. The specimen performance was in accordance with the specification requirements except for interchangeability. The probe does not contain provisions to prevent interchange from one valve to another. Author

N67-35998# National Research Council of Canada, Ottawa (Ontario). Fuels and Lubricants Lab.

LUBRICATING GREASES FOR AERONAUTICAL/AEROSPACE APPLICATIONS

L. D. New *In its* Div. of Mech. Eng. and the Natl. Aero. Estab. 31 Mar. 1967 p 73–78 refs (See N67-35995 21-34)

Military specifications for lubricating greases in aerospace applications are briefly reviewed. Aircraft lubricant requirements are outlined and a few examples (lithium soaps, chiefly hydroxystearates sodium soap, treated natural clays, and substituted ureas) are mentioned to illustrate their variety and application. Operating conditions for high altitude aircraft, and the performance level demanded by today's conventional aircraft are included in a discussion of the response of the various fluid additives to improve performance. Research continues on the optimization of a lubricating fluid that will function efficiently under parameters of high and low temperature and which will be resistant to radiation. R.Li.

N67-36015# NRC Equipment Corp., Newton, Mass.

RESEARCH AND DEVELOPMENT PROGRAM FOR ROCKET-BORNE CRYOSORPTION PUMP Final Report, 15 May 1965–15 Jul. 1966

Richard Hecht Oct. 1966 24 p refs

(Contract AF 19(628)-5171)

(AFCRL-66-768; Rept.-94-18245; AD-654288)

A cryosorption pump, intended for use with a flight mass spectrometer, has been constructed and laboratory tested. The pumping surfaces were formed by first brazing metallized pellets of Zeolon (a synthetic Zeolite) to copper trays, after which the overlying braze was machined away, exposing bare sorbent. The advantages of this process are that the completed pump is free of volatile or corrosive residues, can be baked at temperatures approaching 300C, and has good thermal contact between sorbent and heat sink. The pump was laboratory tested at 77K, the intended operating temperature for flight, by admitting controlled bursts of air, nitrogen, and argon. The shape and intensity of these bursts simulated those to be expected in flight. It was found that pump will maintain pressures within the operating limits of the spectrometer, and that the speed and total gas capacity of the pump are superior to those of previously flown cryosorption pumps, despite the fact that the sorbent areas of the latter pumps substantially exceed the area of this pump. Author (TAB)

N67-38025# Naval Air Engineering Center, Philadelphia, Pa. Aeronautical Materials Lab.
DEVELOPMENT OF INFLATABLE CUSHIONING MODULES FOR PACKAGING APPLICATIONS
D. R. Agnew 1 Mar. 1967 42 p refs
(NAEC-AML-2573; AD-655116)

Results of an investigation indicate that inflatable cushioning modules have excellent cushioning characteristics for the protection of military items against shock and vibration during shipment and storage. Items cushioned by the newly designed, five inch thick, modules have experienced only 38 gs max. when subjected to 30 in. flat drop tests. One such design is functional down to -65F.
Author (TAB)

N67-38029*# Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.
JOINING REFRACTORY/AUSTENITIC BIMETAL TUBING Final Technical Report, Apr. 1965–Oct. 1966
D. R. Stoner Oct. 1966 116 p refs
(Contract NAS3-7621)
(NASA-CR-72275; WANL-PR-(ZZ)-001) CFSTI: HC $3.00/MF $0.65 CSCL 13H

Joining techniques were developed for bimetal tubing intended for applications involving high temperature liquid metal containment. Three basic configurations, the butt joint, tee joint, and tube-to-header joint were produced in quantity and evaluated in terms of performance and ease of fabrication. Gas tungsten arc, plasma arc overlay, and electron beam welding processes were evaluated. Successful joint designs were developed for the three primary joint configurations. The durability of a bimetal joint under severe thermal cycling conditions were determined. Two samples of each joint design were rapidly cycled 20 times from 1350°F to 600°F in a noncontaminating environment. The structural integrity and bond interface condition was determined after thermal cycling. Data are also presented on the strength and efficiency of the butt joint at room temperature and 1350°F. Internal pressure-creep rupture data were obtained for welded and unwelded tubing at 1350°F, for test times up to 1000 hours. Complete metallographic studies of the weld metal and bimetal interface are presented, including microhardness and electron microprobe surveys of weld induced diffusion zones.
Author

N67-38043*# Pratt and Whitney Aircraft, East Hartford, Conn. Research Labs.
RESEARCH AND DEVELOPMENT OF HIGH-PERFORMANCE AXIAL-FLOW TURBOMACHINERY. VOLUME 3: DESIGN OF BACKUP GAS BEARINGS Final Report
J. T. McCabe, W. Shapiro, and T. Y. Chu Washington, NASA, Jun. 1967 250 p refs Prepared for Pratt and Whitney Aircraft
(Contract NAS3-4179)
(NASA-CR-802; PWA-2977, Vol. 3; F-82250) CSCL 13I

Detailed analysis and design data for a gas-lubricated bearing system consisting of two tilting-pad journal bearings with a spiral groove main thrust bearing for a 50,000 rpm Brayton cycle turbine-compressor are presented. Using the working fluid argon as the bearing lubricant, the principal objective was to provide a low friction bearing system of high reliability potential. Extensive steady-state data was generated so that sufficient information was available for system optimization. Having established a preliminary design based on steady-state consideration, a dynamical analysis was undertaken to examine the response of the rotor bearing system to the specified loading. A non-linear rotor journal bearing analysis was formulated, validated, and applied to finalize the preliminary design. Concurrently, the stability of the double acting thrust bearing was investigated. The proposed final design of the bearing system is predicted to meet all the required design specifications.
Author

N67-38078 Skefko Ball Bearing Co., Ltd., Luton (England).
THE DESIGN AND APPLICATION OF ROLLING BEARINGS FOR POWER TRANSMISSION MACHINERY
P. A. Champion [1966] 18 p Presented at the B.G.M.A. Meeting, Coventry (England), 1 Nov. 1966

Requirements for increased bearing load-carrying capacities are examined in relation to their influence on bearing design, higher standards for materials specifications, and improved manufacturing and inspection techniques. The main advantages of rolling bearings are cited, and test rigs for simulating actual service conditions to determine their operational behavior are discussed. Bearing types are assessed according to their particular use and capabilities, and their application to gear drives. The factors influencing bearing life calculations are reviewed.
M.G.J.

N67-38088*# Chrysler Corp., New Orleans, La. Space Div.
RELIEF VALVE, 1- BY 1 1/2-INCH, 100-PSIG, MANNING, MAXWELL, AND MOORE MODEL NUMBER 1970C SPECIAL, NASA DRAWING NUMBER 75M17763 HRV-9 Test Report
Patrick D. M. Rogan 30 Apr. 1967 36 p
(Contract NAS8-4016)
(NASA-CR-88005; TR-RE-CCSD-FO-1032-3) CSCL 13K

Results of tests performed on two specimens of 1- by 1 1/2-inch relief valve 75M17763 HRV-9 are presented. The following tests were performed: receiving inspection, functional, high temperature, surge, cycle, and proof pressure. The performance of the specimens was in accordance with specification requirements. During the cycle test the cracking pressure of both specimens was above 93 psig when measured with LH_2 following each 100 cycles. This high cracking pressure is attributed to the low temperature of the specimens. Following the cycle test, the cracking pressures when measured again at ambient were within the specified limit of 90 (+3, −0) psig. The increase in cracking pressure caused by low temperature is not considered detrimental but indicated that the set pressure must be temperature compensated.
Author

N67-38089* Chrysler Corp., New Orleans, La. Space Div.
CHECK VALVE, 2-INCH, 6000-PSIG, THE ANNIN CO. DRAWING NUMBER A5094, NASA DRAWING NUMBER 75M14693 PCV-1 Test Report
Tom W. Sparks 24 Mar. 1967 55 p
(Contract NAS8-4016)
(NASA-CR-88006; TR-RE-CCSD-FO-1111-3) CSCL 13K

The results are presented of tests performed on one sample of 2-inch check valve 75M14693 PCV-1. The following tests were performed: receiving inspection, proof pressure, functional, flow, surge, low temperature, high temperature, cycle, and burst. Several failures and discrepancies were revealed during testing. A weld burn deposit was revealed inside the inlet port but it did not impair the specimen performance. The specimen does not meet the minimum C_v requirement. The specimen failed the leakage tests following flow due to seat wear and leakage. The specimen cracking pressure increased as the number of cycles increased. On completion of the cycle test the specimen was disassembled and the poppett and poppett bushing were found to be scored and binding. The specimen failed at 21,500 psig due to seal failure.
Author

N67-38090* Chrysler Corp., New Orleans, La. Space Div.
PRESSURE SWITCH, CUSTOM COMPONENTS SWITCHES, INC. PART NUMBER 8G46-1, NASA DRAWING NUMBER 10430405 Test Report
C. L. Foy 9 May 1967 42 p
(Contract NAS8-4016)
(NASA-CR-88007; TE-RE-CCSD-FO-1133-3) CSCL 13G

The requirements, procedures, and results of functional and environmental tests performed on pressure switch 10430405 are described. The switch, which is mounted directly into a pressure line, is used to indicate the presence or absence of gas pressure. The switch was subjected to inspection, proof pressure, vibration, low and high temperature, humidity, and salt fog tests. The test results were satisfactory and the test specimens performed in accordance with specification requirements. R.N.A.

N67-36104* Chrysler Corp., New Orleans, La. Space Div.
HAND OPERATED GATE VALVE 3-INCH, 150-PSIG ALLOY PRODUCTS COMPANY FIG. C-217-EB, NASA DRAWING NUMBER 75M04047 HGV-1 Test Report
Thomas C. Mahony 29 Mar. 1967 70 p
(Contract NAS8-4016)
(NASA-CR-88003; TR-RE-CCSD-FO-1105-3) CSCL 13K

This report presents the results of tests performed on one specimen of hand operated gate valve 75M04047 HGV-1. The following tests were performed: receiving inspection, proof pressure, functional, high temperature, surge, icing, sand and dust, salt fog, cycle, and burst. The specimen successfully met all requirements throughout the test program, except for stem packing gland leakage. The stem packing gland leakage occurred during the functional test while the specimen was in the icing environment. The packing gland was tightened and the icing test was repeated. No further leakage occurred after the packing gland was tightened. Author

N67-36115*# Stanford Research Inst., Menlo Park, Calif.
DEVELOPMENT OF TECHNIQUES TO IMPROVE BLADDER MATERIALS AND TEST METHODS Interim Report, 18 May 1966–17 May 1967
R. F. Muraca 17 Jun. 1967 77 p refs Prepared for JPL
(Contracts NAS7-100; JPL-951484)
(NASA-CR-88126; IR-1) CFSTI: HC $3.00/MF $0.65 CSCL 13H

The investigation of process parameters for the preparation of films from Teflon dispersions is described and data are presented on the characterization of experimental films; these data include values for physical and mechanical properties, such as tensile strength, permeability, degree of crystallinity, and identification of impurities or additives in the raw dispersions. Various approaches to the long-term detection of permeation of N_2O_4 or N_2H_4 through Teflon membranes are discussed and the laboratory procedures for testing the permeability of Teflon films to N_2O_4 is described in detail. The determination of crystallinity of Teflon films by X-ray diffraction, infrared spectrophotometry, and differential thermal analysis has been examined and preliminary correlations are expressed. A bibliography has been compiled for the preparation and characterization of Teflon films. Author

N67-36119# Waterloo Univ. (Ontario). Mechanical Engineering Dept.
CASTING SCIENCE
M. J. Hillier 1967 250 p refs
CFSTI: HC $3.00/MF $0.65

The text is presented of a study course designed to indicate possible applications of basic engineering sciences to the metal casting manufacturing process. A series of models, varying in validity and applicability, are given on aspects of the casting process. These include the casting sequence, solidification of metals, heat transfer, solidification time, fluid flow, paving time, the sand mold, mechanics of sand molding, and die casting. M.G.J.

N67-36121* Chrysler Corp., New Orleans, La. Space Div.
GATE VALVE, MANUALLY OPERATED, 6-INCH, 150-POUND Test Report
Tom W. Sparks 15 Mar. 1967 26 p
(Contract NAS8-4016)
(NASA-CR-88127; TR-RE-CCSD-FO-1094-3) CSCL 13K

This report presents the results of tests performed on one sample of a manually operated gate valve. The following tests were performed: (1) Receiving Inspection, (2) Proof Pressure, (3) Functional, (4) High Temperature. The results of the tests performed were satisfactory. The performance of the specimen was in accordance with specification requirements. Testing of the manually operated gate valve was discontinued after the high temperature test. Due to a material compatibility problem encountered, the manufacturer has recommended certain design modifications. Author

N67-36156* Chrysler Corp., New Orleans, La. Space Div.
RELIEF VALVE, 3/8-INCH, MISSION PUMP AND VALVE CO. PART NUMBER 1-3688, NASA PART NUMBER 75M15044 PRV-4 Test Report
G. Collins 5 Apr. 1967 48 p
(Contract NAS8-4016)
(NASA-CR-88118; TR-RE-CCSD-FO-1126-3) CSCL 13K

Results of the following tests performed on three specimens of a 3/8-inch relief valve are presented: receiving inspection, proof pressure, functional, temperature shock, flow, surge, and cycle. One specimen failed to reseat when the pressure was lowered to the minimum acceptable pressure of 28 psig. Failure occurred during the first cycle of the initial functional test. Another failed to reseat at 28 psig during the functional test following the flow test. A third specimen failed to reseat during the functional test following 50 successful operations of the cycle test. Leakage was recorded in excess of 120 sccm while specimen was pressurized at 28 psig. Author

N67-36193* Chrysler Corp., New Orleans, La. Space Div.
ANACONDA METAL FLEX HOSE VACUUM JACKETED 3/4-INCH I.D. BY 5 FT. LONG, ANACONDA PART NUMBER 83986, NASA DRAWING NUMBER 75M12944 FVJH-3 Test Report
R. A. Fee 20 Mar. 1967 45 p
(Contract NAS8-4016)
(NASA-CR-88004; TR-RE-CCSD-FO-1081-3) CSCL 13K

The flex hose is used as an LH_2 supply hose to the fuel cell in the service module of the spacecraft support system at the John F. Kennedy Space Center. The following tests were performed: (1) receiving inspection; (2) proof pressure; (3) functional; (4) life cycle; (5) flow; (6) high temperature; and (7) burst. The hose met all specifications and requirements. K.W.

N67-36194* Hughes Aircraft Co., Culver City, Calif. Materials Technology Div.
TEST PROGRAM TO STUDY THERMAL STERILIZATION EFFECTS ON CONNECTOR CUP SOLDER JOINTS AND DETERMINE THE OPERATING PARAMETERS FOR APPLICATION OF SOLDERS Final Report
F. Z. Keister and J. H. Holley 14 Jun. 1967 82 p Prepared for JPL
(Contracts NAS7-100; JPL-951663)
(NASA-CR-88002; P67-130) CSCL 13H

Bendix and Cinch connector cups were studied for application of Sn 96, Sn 63, Sn 62, and Sb 5 solder alloys at thermal sterilization conditions of 135°C for 552 hours and 145°C for 108 hours. A total of 634 joints was prepared, examined before and after thermal sterilization, and tested for ultimate strength, electrical resistance, metallurgical properties, and stress–rupture strength. Statistical analysis of the test results revealed no significant effects of either sterilization process on ultimate strength, electrical resistance, or metallurgical properties. The Sb 5 solder is strongest under conditions of temperature and stress, the Sn 63 solder is the weakest. Joint combinations with the Bendix connector cups are slightly stronger than those with Cinch connector cups. Thermal sterilization at 145°C for 108 hours appears to be more degrading than at 135°C for 552 hours. K.W.

N67-36207*# Stanford Univ., Calif.
THE DESIGN OF MECHANICAL LINKWORK FOR AEROSPACE
Bernard Roth *In* JPL 2d Aerospace Mech. Symp. 15 Aug. 1967 p 25–32 refs (See N67-36203 21-31)

Examples are given to illustrate common types of kinetic synthesis problems pertaining to the relative motion of two bodies, and points moving on specified point-paths. The examples discussed focus on spatial mechanisms, and their application to the aerospace industry where the possibility of obtaining complex motions with fewer parts is considered especially attractive. The solutions proposed involve either of two methods: (1) The geometrical constraint method relies on determining those special points or lines in a moving body which have several positions on a specified locus, such as a circle, sphere, cylinder, hyperboloid, etc. (2) In the direct method a set of equations is derived to relate the unknown linkage dimensions to the specified linkage motion requirements. Both methods generally require the solution of a nonlinear set of algebraic equations and the use of a digital computer. A selected bibliography on the synthesis of planar linkages and spatial linkages is included. M.G.J.

N67-36217*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
THE BEHAVIOR OF LUBRICATION SYSTEM COMPONENTS IN A VACUUM ENVIRONMENT
Donald H. Buckley *In* JPL 2d Aerospace Mech. Symp. 15 Aug. 1967 p 111–120 refs (See N67-36203 21-31)

Studies were conducted in a vacuum environment with various lubricants and the material to be lubricated. Evaporation experiments were conducted with various fluids, greases, inorganic compounds and soft metals. Friction, adhesion, and wear experiments were conducted with the various materials used in lubrication systems. The results of these studies indicated that, while relatively high rates of evaporation may be obtained for conventional oil and grease lubricants, these materials may be effectively utilized if concepts such as molecular flow seals are used to reduce evaporative losses. Further, for prolonged exposure to vacuum environment, many inorganic compounds and soft metal films have potential usefulness. In addition to evaporation losses, concern must be given to the type of lubricant that is used. With conventional lubricants, degassing of the fluids can present a problem. The results of sliding friction experiments in a vacuum environment indicate that there are basic metallic structures that have markedly superior friction wear and less tendency to adhere than bearing materials now conventionally used. Selective alloying of these metallic structures could be effectively used to prepare alloys specifically designed for use in lubrication mechanisms. Author

N67-36218*# Lockheed Missiles and Space Co., Sunnyvale, Calif.
LUBRICATION AS PART OF TOTAL DESIGN
Francis J. Clauss *In* JPL 2d Aerospace Mech. Symp. 15 Aug. 1967 p 121–124 (See N67-36203 21-31)

Oils and greases, if properly selected, may solve many lubrication problems in space. Ball bearings must also be properly selected and must be protected from contamination. Operating temperatures should be accurately specified. For heavily loaded gears, MoS_2 films have been used successfully. Author

N67-36219*# California Univ., Berkeley.
SURFACE INTERACTION BETWEEN ALUMINUM SINGLE CRYSTALS AT 10^{-10} TORR
Joseph Frisch *In* JPL 2d Aerospace Mech. Symp. 15 Aug. 1967 p 125–130 (See N67-36203 21-31)

Friction and adhesion between metallic surfaces in ultrahigh vacuum have been studied by subjecting aluminum crystals to forces of 0.1 to 10 lb at 10^{-10} torr. Surface galling, distortion, and adhesion resulted. The adhesion was apparently caused by localized interaction of asperities that welded together and prevented separation of the crystals. Author

N67-36282*# Chrysler Corp., New Orleans, La. Space Div.
RELIEF VALVE, 6 BY 8 INCH, MANNING, MAXWELL, AND MOORE PART NUMBER TYPE 1905 QC/L3, NASA DRAWING NUMBER 75M12930 LRV-7 Test Report
Donald R. Hardwick 24 Mar. 1967 55 p
(Contract NAS8-4016)
(NASA-CR-88111; TR-RE-CCSD-FO-1027-3) CSCL 13K

The valve is used at Launch Complex 37 of the John F. Kennedy Space Center to prevent overpressurization of the inner LOX tank. Three specimens of the valve were tested for the following: (1) receiving inspection; (2) functional; (3) high temperature; (4) flow; (5) surge and response; (6) cycle; and (7) proof pressure. The specimens met operational and environmental requirements and performed according to specifications. K.W.

N67-36301* Chrysler Corp., New Orleans, La. Space Div.
REFRIGERANT EXPANSION VALVE, ALCO PART NUMBER TAC-45HW100, NASA DRAWING NUMBER 75M04406 PTR-8 Test Report
M. R. Watts 3 Apr. 1967 42 p
(Contract NAS8-4016)
(NASA-CR-88079; TR-RE-CCSD-FO-1078-3) CSCL 13K

Results of the following tests performed on one specimen of refrigerant expansion valve are presented: receiving inspection, proof pressure, functional, and cycle. The specimen performance was in accordance with specification requirements throughout the test program with the exception of a small leak through the modulator casting. The leak did not effect specimen function. Author

N67-36389* Chrysler Corp., New Orleans, La. Space Div.
REFRIGERANT EXPANSION VALVE, ALCO PART NUMBER TAC-22HW100, NASA DRAWING NUMBER 75M04406 PTR-1 Test Report
M. R. Watts 3 Apr. 1967 42 p
(Contract NAS8-4016)
(NASA-CR-88080; TR-RE-CCSD-FO-1077-3) CSCL 13K

A test program was conducted to determine if the refrigerant expansion valve meets the operational requirements for the Kennedy Space Center Launch Complexes 34 and 37B. The valve, which is thermostatically controlled and equipped with a pressure controlled modulator and an external equalizer, controls the flow of refrigerant to the evaporator in the air condition units on the launch complexes. Test data are presented to show that the performance was in accordance with the specification requirements. M.G.J.

N67-36391*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EFFECT OF RECRYSTALLIZATION ON FRICTION PROPERTIES OF SOME METALS IN SINGLE-CRYSTAL AND POLYCRYSTALLINE FORM
Donald H. Buckley Washington, NASA, Sep. 1967 20 p refs
(NASA-TN-D-4143) CFSTI: HC $3.00 CSCL 11F

An investigation was conducted with sliding friction experiments to determine the influence of recrystallization and texturing of various metals in sliding on friction coefficients. The metals examined in this investigation included copper, nickel, iron, tungsten, beryllium, and titanium. These metals were examined in their single-crystal and polycrystalline forms. The mating surface

in sliding friction experiments was polycrystalline aluminum oxide. Experiments were conducted at a sliding velocity of 0.001 centimeter per second with no external heating of the specimens. A change in release of interface frictional energy to produce recrystallization for the various metals in sliding contact with polycrystalline aluminum oxide was achieved by changing the load. All experiments were conducted in a vacuum of 10^{-11} torr (1.33×10^{-9} N/m^2) with specimens which had been electron bombarded to clean their surfaces. The results of the investigation indicate that, at relatively modest loads, recrystallization and texturing will occur for some of the highest melting point metals. For example, tungsten, which has a recrystallization temperature of 1200°C, recrystallized and textured at the surface with a load of 3500 grams. The process of recrystallization and texturing produces very marked changes in friction coefficients. The higher the recrystallization temperature of a metal, the higher the load at a constant sliding velocity needed to produce recrystallization. Prior to recrystallization, all metals exhibited lower friction coefficients for single-crystal orientations than for the metals in their polycrystalline form. Author

N67-36396# Monsanto Research Corp., Dayton, Ohio.
INJECTION MOLDING RESEARCH AND DEVELOPMENT Final Report, Sep. 30, 1965–Sep. 30, 1966
Ival O. Salyer, George L. Ball, III, and William E. Welch Mar. 1967 63 p Prepared for Calif. Univ., Livermore. Lawrence Radiation Lab.
(Contract W-7405-ENG-48)
(UCRL-13287) CFSTI: HC$3.00/MF$0.65

Quantitative comparisons of hot die and conventional molding techniques with respect to processing characteristics and physical properties of molded parts of polycarbonates were made. Clearly defined process and product advantages of the hot molding technique justify the higher cost, longer cycles, and greater complexity inherent in this process. Favorable results are consistent with the explanation that injection of the carbonate, or other polymer, melt in a die which is above the glass transition temperature, minimizes the tremendous instantaneous increase in melt viscosity, which takes place with injection into a cold die (conventional molding). Gate closure and die sealing can be delayed and molten polymer added during cooling, offsetting volume decrease from thermal contraction during cooling and setting. NSA

N67-36414* Chrysler Corp., New Orleans, La. Space Div.
TEST REPORT FOR CHECK VALVE, 3/4-INCH FUTURECRAFT CORPORATION PART NUMBER 60291
Vincent D. Zimmerman 13 Feb. 1967 51 p refs
(Contract NAS8-4016)
(NASA-CR-88125; TR-RE-CCSD-FO-1114-3) CSCL 13K

This report presents the results of tests performed on one specimen of check valve 75M09618 PCV-2. The following tests were performed: receiving inspection, proof pressure, functional, flow, surge, cycle, and burst. Degradation of the specimen was noted during the surge test and the cycle test in terms of cracking and reseating pressures. The flow coefficient of the specimen was 4.13 as compared with the 7.0 minimum specified. The low flow coefficient was caused by the 3/4-inch XXS Grayloc end connections rather than the specimen. The internal diameter of the Grayloc end connections was smaller than the minimum diameter necessary to allow a flow coefficient of 7.0. Prior to the cycle test, approximately 4 milliliters per minute internal leakage was measured past the valve seat when the specimen outlet port was pressurized with He to 6000 psig. No internal leakage is allowable. This leakage was not considered serious and remained unaltered through the cycle test. Author

N67-36415* Chrysler Corp., New Orleans, La. Space Div.
TEST REPORT FOR GLOBE VALVE, 2-INCH ANNIN COMPANY PART NUMBER A4825
Vincent D. Zimmerman 7 Mar. 1967 63 p refs
(Contract NAS8-4016)
(NASA-CR-88123; TR-RE-CCSD-FO-11213) CSCL 13K

Results are presented of tests performed on one specimen of globe valve 10428530. The following tests were performed: receiving inspection, proof pressure, functional, flow, surge, low temperature, high temperature, and cycle. The valve performance during the receiving inspection, proof pressure, flow, and low and high temperature tests met the requirements. However, failures occurred in the initial functional test in terms of operating torque. Major failures occurred during the surge test when the valve seat ruptured and during the cycle test when the valve was rendered inoperable as a result of fatigue of the upper thrust bearing. All further testing was discontinued and the burst test was not performed. Author

N67-36416*# Chrysler Corp., New Orleans, La. Space Div.
TEST REPORT FOR RELIEF VALVE, 1-INCH BY 950-PSIG 950-PDIH ANDERSON–GREENWOOD CO. PART NUMBER 61S88-6 (SPECIAL)
R. A. Fee 26 Apr. 1967 28 p refs
(Contract NAS8-4016)
(NASA-CR-88124; TR-RE-CCSD-FO-1101-3) CSCL 13K

The results are presented of tests performed on three specimens of relief valve 75M12944 FRV-1. The following tests were performed: receiving inspection, proof pressure, and functional. The test specimen did not meet the requirements during the initial functional test. The cracking and reseat pressures were not within the specified tolerances and severe leakage occurred at the valve seat. Testing was discontinued after the initial functional test. Author

N67-36449 Joint Publications Research Service, Washington, D. C.
STORAGE AND TRANSPORT OF LIQUEFIED HYDROGEN AND HELIUM COVERINGS FOR LIQUEFIED-GAS STORAGE CONTAINERS
P. M. Gofman-Zakharov 22 Aug. 1967 17 p Transl. into ENGLISH from the book "Nizkotemperaturnoye Khraneniye Szhizhennykh Tekhnicheskikh Gazov" Kiev, Izd. Tekhn., 1966 p 127–133, 141–145
(JPRS-42287; TT-67-32916) CFSTI: $3.00

Brief summaries are presented on technical applications of low temperature storage of liquefied gases. Longitudinal cross sections depict special heat-insulating containers to store liquefied gas. Low-temperature storage and transport facilities of liquefied hydrogen and helium are also described. R.U.

N67-36495# Mechanical Technology, Inc., Latham, N. Y.
THE PRELIMINARY INVESTIGATION OF FLUIDIC TECHNOLOGY AS APPLIED TO GAS BEARINGS TO IMPROVE STIFFNESS
William E. Be Vier Jun. 1967 60 p refs
(Contract Nonr-3730(00)(FBM))
(MTI-67TR31; AD-654717)

Fluidic control of gas bearing film thickness is investigated. A control system is proposed and the equations governing the proposed system are developed. The concept is shown to be feasible and a significant improvement in film thickness characteristics of the bearing results. Author (TAB)

N67-36561* National Aeronautics and Space Administration, Washington, D. C.
SOME METHODS FOR FORMING AND SINTERING CARBIDES [NEKOTORYE METODY FORMOVANIYA I SPEKANIYA KARBIDOV]
Edmund Bryjak and Kryzant Lesniak Nov. 1966 27 p refs Transl. into ENGLISH from Poroshkovaya Met., Akad. Nauk Ukr. SSR (Kiev), v. 6, no. 4, 1966 p 85–109
(NASA-TT-F-10425) CSCL 13H

Powder metallurgy methods are reviewed for obtaining products of complex form from sintered carbides, developed at the Baildon steel mill near Katovice, Poland. Machinery, processes, and technical specifications for the production of cogged wheels, complex matrices, and other special machine parts by casting, extrusion, and other techniques are discussed in detail. Author

N67-36575# Massachusetts Inst. of Tech., Cambridge.
MATERIALS ENGINEERING
In its Res. in Mater. Sci. and Eng. Apr. 1967 p 243–309 refs
(See N67-36571 21-26)

Summaries are presented under the general categories of deformation, fracture, and mechanics; structural materials; surface properties and materials behavior and processes; effects of radiation on materials; chemical engineering of materials; and the cryogenic laboratory. These progress reports deal with subjects such as plastic deformation and strain hardening, properties of fiber composites and polymers, and shell dynamic response. Other materials considered are rocks, Portland cement concrete, crystalline polymers, hydrated cements, reinforced plastic composites, metallic composites, and tungsten wire. Properties of polyelectrolyte complexes, polymer characterization, and the sorption and transport of gases and liquids in polymers are reported. Catalysis studies are concerned with semiconductors, interphase interactions in solid catalysts, diffusion in porous materials, and molecular sieve catalysts. M.W.R.

N67-36588# General Dynamics/Pomona, Calif.
CLEANSWEEP IV, PHASE II Final Status Report
15 Feb. 1967 41 p refs Prepared for Calif. Univ., Livermore. Lawrence Radiation Lab.
(Contract W-7405-ENG-48)
(UCRL-13275) CFSTI: HC $3.00/MF $0.65

A summary of the work performed during Phase II of the Cleansweep IV while design program is presented. Primary emphasis is directed toward presenting a review of the mechanical design aspects of the Cleansweep vehicle, and presenting the latest sampling performance estimates of the Cleansweep IV vehicle. Design and fabrication of two prototype Cleansweep IV vehicles was the primary objective of the Phase II program. At program termination, approximately 65% of the vehicle design studies had been completed. Only negligible hardware fabrication and component testing had been undertaken at time of program cancellation. No major design problems were encountered at any time during the program. Author (NSA)

N67-36597# Sandia Corp., Livermore, Calif.
NEW DESIGN OF CF CABLES
J. A. Balaban May 1967 21 p
(Contract AT(29-1)-789)
(SCL-DR-67-24) CFSTI: HC $3.00/MF $0.65

A new method of making firing cables (CF cables), utilizing various combinations of shrink-fitted sleeves and boots with encapsulating compounds, produces cables that will meet a wide range of electrical, mechanical, and environmental requirements. A typical step-by-step assembly procedure is given. Author (NSA)

N67-36601* Chrysler Corp., New Orleans, La. Space Div.
PNEUMATIC FILTER 1/2-INCH PERMANENT FILTER CORPORATION PART NUMBER 10011-P-5/15, NASA DRAWING NUMBER 75M04406 PF-3 Test Report
A. Pastor 28 Nov. 1966 50 p
(Contract NAS8-4016)
(NASA-CR-84754; TR-RE-CCSD-FO-1098-3) CSCL 13G

This report presents the results of tests performed on one sample of Pneumatic Filter. The following tests were performed: (1) Receiving Inspection, (2) Proof Pressure, (3) Functional, (4) Flow, (5) Dirt Holding and Collapse Pressure, and (6) Burst. The specimen performance was in accordance with the specification requirements throughout the test program with exception of the micron rating which was determined to be 26.7 microns as opposed to the specification requirement of 10 microns. Author

N67-36615* Chrysler Corp., New Orleans, La. Space Div.
PRESSURE REGULATORS, GROVE VALVE AND REGULATOR COMPANY PART NUMBERS T-1538 AND T-1541, NASA DRAWING NUMBERS B75M50305-1 AND B75M50305-4 Test Report
Robert Kilowith 3 Apr. 1967 63 p
(Contract NAS8-4016)
(NASA-CR-88213; TR-RE-CCSD-FO-1020-3) CSCL 13G

Pressure regulators, differing only in orifice size, were subjected to receiving inspection, proof pressure, functional, prolonged pressure, low temperature and high temperature tests. Not all of the specification requirements were met. The proof pressure of 9000 psig, applied to all three ports simultaneously, resulted in permanent structural deformation of the regulator dome and body. Leakage occurred at the body plug at an inlet pressure above 8000 psig. Excessive leakage at the dome and regulator body interface occurred at specimen temperatures of +5°F and below. Some of the body bolt torque values were below the specified value when measured at low temperature. The high temperature test resulted in excessive external leakage at the regulator body plug. The body plug torque values were below the specified value when measured at high temperature. Author

N67-36660*# National Aeronautics and Space Administration, Washington, D. C.
SOLDERING ELECTRICAL CONNECTIONS A Handbook
1967 67 p 4th ed.
(NASA-SP-5002) GPO: $0.30 CSCL 13H

This handbook presents methods of preparing strong, dependable electrical connections for space applications by improved soldering techniques. The areas discussed are: hand soldering, automatic machine soldering, termination of shields by soldering, and lacing of cable trunks. Color codes, solder characteristics and cracking problems are included in the appendix. J.L.C.

N67-36668*# National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, Fla.
STANDARD FOR COLOR CODE FOR SHOP MACHINERY AND EQUIPMENT
21 Feb. 1967 18 p refs
(NASA-TM-X-60222; KSC-STD-S0003) CFSTI: HC $3.00/MF $0.65 CSCL 13H

A color code standard has been generated and approved for mandatory use by Kennedy Space Center and associated contractors. The standard specifies color codes for shop machines, tools and similar equipment used only in interior environments. The code serves to alert personnel by highlighting hazardous or critical areas associated with the machine tool or equipment. C.L.W.

16 MASERS

Includes applications of masers and lasers. For basic research see: 26 Physics, Solid State.

N67-35311# Harvard Univ., Cambridge, Mass. Div. of Engineering and Applied Physics.
THE STIMULATED RAMAN EFFECT
N. Bloembergen Apr. 1967 110 p refs
(Contract Nonr-1866(16))
(TR-525; AD-654536) CFSTI: HC $3.00/MF $0.65

The paper reviews the main experimental and theoretical developments in stimulated Raman scattering of light, which has been actively investigated since 1962. The effect cannot be discussed properly without paying attention to related nonlinear effects which include stimulated Brillouin and Rayleigh scattering, self-focusing of light and modulation of the refractive index. The physical processes are enphasized and no encyclopedic survey of all the data and the research literature is attempted, but a brief historical account is added in the final section. Author (TAB)

N67-35330# Army Electronics Labs., Fort Monmouth, N. J.
CO_2 MOLECULAR GAS LASER
Charles J. Bickart and John N. Fulton Mar. 1967 43 p refs
(ECOM-2818; AD-654518)

The report discusses the experimental results and optimization of a relatively high-power, high-efficiency CW gas laser utilizing a dc excited discharge with a flowing combination of carbon dioxide, helium, and nitrogen as the active laser medium. Continuous laser power output of 126 watts has been measured from a system of 4.7 cm diameter by 2.4 meters long. Details of the various cavity configurations, reflector materials, power coupling-out methods and current characteristics of the discharge are discussed. A 90 degree folded design cavity is described including some intra-cavity Q-switching experiments. These experiments are part of a continuing study of the technology concerning design, construction and optimization of CO2 lasers. Author (TAB)

N67-35382# Florence Univ. (Italy).
MODES IN STABLE AND UNSTABLE REGIONS OF THE FLAT-ROOF OPEN RESONATOR
P. F. Checcacci, A. Consortini, and A. M. Scheggi Feb. 1967 54 p refs
(Contract AF 61(052)-871)
(AFCRL-67-0357; SR-5; AD-654319)

The integral equation of a flat-roof resonator is solved by the Fox and Li method of iterations in a number of particular cases. Mode patterns, phase shifts and power losses are derived as functions of the roof angle and of mirror aperture. A good over all agreement is found with the approximate theory previously developed by Toraldo di Francia. High loss regions are also observed. The behavior of different modes in such regions is investigated in detail. Experimental tests carried out on a X-band model give a confirmation of the theoretical predictions. Author (TAB)

N67-35538# Honeywell, Inc., Hopkins, Minn. Corporate Research Center.
MECHANISMS OF LASER-SURFACE INTERACTIONS Final Report
J. F. Ready, E. Bernal, and L. T. Shepherd May 1967 93 p refs
(Contract DA-18-001-AMC-1040(X))
(AD-654524) CFSTI: HC $3.00/MF $0.65

This report describes experimental and theoretical investigations of the particle emission produced in the laser-surface interaction. Preliminary measurements on the angular distribution of ions emitted from a tungsten target at power levels around 14 MW per sq. cm. indicate anisotropy of the emission, with a strong enhancement in directions near the normal to the target. Ion and neutral molecule emission from laser-irradiated sodium targets are described. Calculations on the free expansion of the laser-produced blow off material, which include the asymptotic velocity of the expansion, yield pulse shapes similar to those observed experimentally if a high initial temperature is assumed. The magnitudes and time histories of shock waves produced in the target by absorption of the laser radiation have been calculated. Author (TAB)

N67-35611# Corning Glass Works, N. Y.
GLASS LASER DAMAGE RESEARCH Final Technical Report, Jan. 1966–Jun. 30, 1967
R. D. Maurer, W. W. Lester, and M. E. Vance 30 Jun. 1967 95 p refs
(Contract N00014-66-C0158; ARPA Order 306; Proj. Defender)
(AD-654727)

The report covers an experimental investigation into the damage of glass by high intensity, 1.06 micron wavelength light pulses of millisecond duration. Damage due to optical absorption by impurities is demonstrated by ease of damage, above some intrinsic level, proportional to the measured optical absorption. An additional source of damage is optical absorption at 1.06 micron from the excited (fluorescing) state of the neodymium ion. Evidence for this mechanism is presented, and an approximate value of the excited state absorption cross section determined. The nonradiative decay (heating) back to the initial excited state is assumed to be the source of damage, and this appears reasonable from other data. Studies of opto-acoustic coupling are presented and their connection with stimulated Brillouin scattering denoted. Measured coupling constants for different glasses, which are shown to be devoid of impurity optical absorption effects are presented. Stimulated Brillouin scattering as a cause of damage suggests correlation between these opto acoustic coupling constants and damage thresholds. Initial qualitative agreement between the two is encouraging enough to warrant further investigation of this technique as a way of predicting damage thresholds. Author (TAB)

N67-35629*# Perkin-Elmer Corp., Norwalk, Conn.
DEVELOPMENT AND FABRICATION OF RING LASER SYSTEMS
P. H. Lee Dec. 1966 178 p
(Contract NAS8-11669)
(NASA-CR-88193; TR-8641) CFSTI: HC $3.00/MF $0.65 CSCL 20E

The theory and operation of the ring laser rotation sensor is presented. The instrument and its component parts are described in detail. The laser embodies a complex optical resonator having controls for gain, nonreciprocal time delay, nonreciprocal transmission, and overall loss. The report also gives the system performance, conclusions, and recommendations. Author

N67-35660# Avco Corp., Wilmington, Mass. Space Systems Div.
A STUDY OF METHODS TO MEASURE THE EFFECTS OF A CONTAMINATED ATMOSPHERE ON THE TRANSMISSION OF A HIGH ENERGY LASER BEAM Final Report
Robert Schlier et al May 1967 153 p refs
(Contract DA-18-001-AMC-957(X))
(AVSSD-0183-67-RR; AD-654786) CFSTI: HC $3.00/MF $0.65

This report is concerned with the transmission of a high energy laser beam through an atmosphere containing aerosols. The experimental approach consists essentially in firing a high energy laser beam through an instrumented test chamber in which various known aerosols can be introduced. Various analyses are presented of the effects which may be expected, and experiments are described to demonstrate these effects. Breadboard experiments have been performed to verify certain experimental techniques and their description with some experimental results indicating a nonlinear interaction are included in this report. Finally, the specifications of an experimental test chamber in which laser beam experiments (at pressures up to 10 atmospheres) can be performed are included. Author (TAB)

N67-35695# Princeton Univ., N. J. Frick Chemical Lab.
CHARGED PARTICLE EMISSION AFTER RUBY LASER IRRADIATION OF TRANSPARENT DIELECTRIC MATERIALS
W. E. Falconer (Bell Telephone Labs., Murray Hill, N. J.), D. L. Rousseau, and G. E. Leroi Jun. 1967 29 p refs
(Contract Nonr-1858(26))
(TR-7; AD-655105)

Ion currents induced by high power laser irradiation of transparent dielectric materials in vacuo below the threshold for physical damage have been investigated. Soft glass, Pyrex, fused quartz, Supracil quartz, CaF2, LiF, and sapphire all show similar behavior. Currents as large as 10 billion ions/pulse are obtained using ruby radiation with normal mode power levels of about 200 kW. Both positive and negative ion signals were studied, and for the latter case two distinct signals have been time resolved using Q-switched pulses. The emission is qualitatively similar to related investigations of laser irradiated metal surfaces. These effects are ascribed to laser heating of dust and other surface contaminants with subsequent production of high energy photons and thermionic emission of electrons and ions. The emission of photons, electrons and ions can be reduced, but not completely eliminated, by careful precleaning and repeated lasing on the dielectric surface. Author (TAB)

N67-35785# Westinghouse Electric Corp., Pittsburgh, Pa. Research Labs.
ARC DISCHARGE SOURCES Final Report, 16 Oct. 1964–28 Feb. 1967
Charles H. Church, B. W. Swanson, J. Lowke, R. Liebermann, P. Buchhave, et al 31 Mar. 1967 190 p refs
(Contract Nonr-4647(00); ARPA Order 306-62; Proj. Defender)
(RR-67-9C1-ARCSO-R1; AD-654718)

The report summarizes the studies towards the development of models for the highly radiative arcs used for the high energy pumping of lasers. The report also presents the experimental and theoretical studies since the last semiannual report. The experimental investigations were primarily concerned with more extensive measurements of the spectral radiance of the plasma to provide verification for the models. The theoretical work has resulted in computer methods, described in the appendices, to calculate the transport properties, the spectral absorptivities for the lines and the continuum of xenon, and the spectral radiance and temperature profiles in cylindrical arcs. Also included as an appendix is a theoretical analysis of the xenon arc using radiative transport techniques developed in other studies. Author (TAB)

N67-35861*# Stanford Univ., Calif. Microwave Lab.
INVESTIGATION OF LASER DYNAMICS, MODULATION AND CONTROL BY MEANS OF INTRA-CAVITY TIME VARYING PERTURBATION Semiannual Status Report, 1 Feb.–1 Aug. 1967
S. E. Harris Aug. 1967 31 p refs
(Grant NGR-05-020-103)
(NASA-CR-88272; ML-1566; SASR-3) CSCL 20E

Studies were conducted on optical parametric fluorescence and a continuous-wave high efficiency parametric oscillator. Theoretical predictions were made concerning the optical parametric fluorescence in $LiNbO_3$. Optical parametric oscillators using krypton and argon lasers as the pump were designed. Lithium niobate was the nonlinear material used in both. An optical fluorescence that was thermally tunable over a significant portion of the visible and near infrared spectrum is reported. Single frequency light from an argon FM laser was examined. It is pointed out that the single frequency light obtained by this technique is inherently stable to within one cavity mode spacing (c/2L). Furthermore, it can be absolutely frequency stabilized to some point near the center of the Doppler line. Finally, consideration is given to the threshold for a multimode parametric system consisting of a set of idler modes with the same c/2L frequency spacing as the laser pump source, all coupled through a nonlinear element of a single signal mode. S.P.

N67-35879# Toronto Univ., (Ontario). Dept. of Physics.
NORMAL AND STIMULATED RAMAN SPECTROSCOPY Semiannual Reports, 1 Jun. 1966–31 Dec. 1966
Boris P. Stoicheff, F. Shimizu, A. K. McQuillan, W. Clements, and U. Bachmann Apr. 1967 34 p refs
(Contract Nonr-5012(00); ARPA Order 306)
(SAR-1, 2, 3; AD-654725)

The report is in three parts: (1) gives a detailed account of experiments on the angular dependence of stimulated Raman emission in diamond. The observed cone angles of Stokes and anti-Stokes radiation produced by incident parallel light agree with the momentum-matching condition for plane waves. Furthermore, it was found that the cone angles were independent of laser intensity, but sensitively dependent on the angle of convergence of the incident laser radiation. These observations are explained on the basis of the available theory of the stimulated Raman process. (2) Reports on first observation of so-called surface radiation in stimulated Raman scattering. In pure acetone and cyclohexane, usually Class I radiation is observed. In mixtures with 5 to 10% CS2 we have observed first-order anti-Stokes emission (at nuR = 2920/cm for acetone and 2850/cm for cyclohexane) in sharply defined cones which obey the wave-vector relation k1 cosine theta = 2ko-k1. This implies that only the longitudinal and not the transverse components of the phase velocities sum to zero. (3) Describes a technique, using a He-Ne laser of 250 m W output and 750 Mc/sec (or 0.025/cm) line width, for measuring spontaneous Raman line widths. The 656/cm band of liquid CS2 was found to have a line width of 0.47 plus or minus 0.05/cm. This yields for the calculated gain in the stimulated emission a value of 360 rather than the earlier value of 60. Author (TAB)

N67-35927# Pennsylvania State Univ., University Park. Dept. of Electrical Engineering.
A QUANTUM STATISTICAL ANALYSIS OF A FREQUENCY MODULATED LASER COMMUNICATION SYSTEM
Neil F. Ruggieri 30 Apr. 1967 86 p refs
(Contract DA-31-124-ARO(D)-383)
(AROD-5659-3-E; AD-655119)

In this analysis the quantum statistics of the received signal of a frequency modulated laser communication system are derived. In particular the detection statistics for heterodyne and electric field detection of the frequency modulated laser beam are determined. These detection statistics are used to define a measure of the communication system performance in terms of a signal to noise ratio. The development of the quantum electromagnetic field in terms of the photon annihilation eigenstates is the basis for determining these statistics. The derivation used accounts for fluctuations in the carrier, fluctuations due to background radiation introduced after modulation, fluctuations due to the local laser oscillator, and zero point field fluctuations. The results of this analysis indicate the probability distribution for the optical heterodyne detection is not a familiar one of classical communication theory, but it is of the form of probability distribution that satisfies experimentally measured photocount statistics of unmodulated laser radiation. The probability distribution for the electric field intensity detection of the frequency modulated laser beam is the familiar Gaussian distribution. Author (TAB)

N67-36071# Toronto Univ. (Ontario). Dept. of Physics.
NORMAL AND STIMULATED RAMAN SPECTROSCOPY Semiannual Report, 1 Jan. 1967–31 May 1967
Boris P. Stoicheff and Archie K. McQuillan Jun. 1967 8 p refs
(Contract Nonr-5012(00)); APRA Order 306)
(SAR-4; AD-654726)

Up to the present time measurements of Raman gain have been reported for several liquids and hydrogen gas, but not of solids. We have measured the gain in a diamond crystal. At low laser intensity, spontaneous emission was observed and this increased linearly with increasing laser intensity. At a laser intensity of 0.9

x 10 to the 9th power W/sq. cm., the Stokes intensity increased sharply and at slight increase in laser intensity produced an increase of 100,000 in Stokes output. In our experiments the sharp increase at threshold is expected since the diamond crystal was in the form of a plate and behaved as a resonator. The measured gain/cm is 9.5 x 0.00100 Io where Io is the laser intensity given in MW/sq. cm. This agrees very well with the value g = 8 x 0.00100 Io, calculated from the data on normal Raman scattering. Author (TAB)

N67-36558*# General Telephone and Electronics Labs., Inc., Bayside, N. Y. Research Center.

INVESTIGATION OF ELECTRO-OPTICAL TECHNIQUES FOR CONTROLLING THE DIRECTION OF A LASER BEAM

J. Schlafer, A. J. Campillo, and V. J. Fowler 12 May 1967 80 p refs

(Contract NAS8-11459)

(NASA-CR-88115; TR-67-722.33) CSCL 20E

Two types of optical beam deflectors employing piezoelectrically driven mirrors have been investigated for application in optical acquisition and tracking systems. Operation of the shear-plate-mirror deflector at resonance for increased deflection has pointed up problems of depoling of the piezoelectric element at high strain levels. A new type of deflector, the piezoelectric bender driven mirror, has been developed for large aperture, high resolution applications requiring bandwidths up to a few kilohertz. To obtain more precise information on beam position in optical deflection systems, a number of deflection sensing schemes have been examined. By adapting digital techniques to the direct sensing of spot displacement, improved stability, resolution, and accuracy over analogue deflection sensing methods may be realized. A bender driven mirror deflector and digital deflection sensor have been combined in an optical system which can deflect through ±1400 resolvable spots in two dimensions and measure beam position to within ±1/4 of a spot diameter. Author

17 MATERIALS, METALLIC

Includes cermets; corrosion; physical and mechanical properties of materials; metallurgy; and applications as structural materials. For basic research see: 06 Chemistry. For related information see also: 18 Materials, Nonmetallic; and 32 Structural Mechanics.

N67-35348*# TRW, Inc., Cleveland, Ohio. Materials and Processes Dept.

DEVELOPMENT OF HIGH TEMPERATURE NICKEL-BASE ALLOYS FOR JET ENGINE TURBINE BUCKET APPLICATIONS Summary Report, 1 Apr. 1965–31 May 1967

H. E. Collins 20 Jun. 1967 293 p refs

(Contract NAS3-7267)

(NASA-CR-54507; TRW-ER-7162) CSCL 11F

Task I was a screening study where 75 experimental compositions were melted, cast, and evaluated on the basis of mechanical property, micro-structure, and workability results. The elements studied as alloy additions were Ta, W, Mo, Ti, Cb, V, Hf, Re, Ru, Al, Cr, Co, C, and Zr. Ta, W, Hf, Al, and Cr appeared to be the elements most influential in improving stress rupture life. In general, the elements and levels which increased the life also increased tensile strength, but they normally decreased ductility and workability. In Task II, a more complete property evaluation was performed on the three most promising cast alloys and the five most promising wrought alloys derived in Task I. The results of this evaluation showed that Alloy VI A had the best combination of high temperature properties of the three cast alloys. It represents a substantial improvement in stress rupture life with an approximate 50°F increase in temperature over the lives of present-day high strength nickel-base alloys. The results also showed that four of the five alloys, Alloys I-5, IIb, IId, and IIIg, were promising wrought alloys. Author

N67-35349*# Massachusetts Inst. of Tech., Cambridge. Dept. of Metallurgy.

RESEARCH ON MECHANISMS OF ALLOY STRENGTHENING Semiannual Report

Nicholas J. Grant Jun. 1967 19 p

(Grant NsG-117-61)

(NASA-CR-87992) CFSTI: HC $3.00/MF $0.65 CSCL 11F

There are two aims to this program, namely: a) Studies of oxide dispersion strengthened alloys, to establish strengthening mechanisms, to examine deformation and fracture behavior, and generally to improve thereby the structure and properties of such alloys; b) Studies to determine the potential of rapidly quenched liquid metal droplets as a basis for alloy development (splat cooling). The very large changes in solute solubility; the extreme refinement of grain size, dendrite size, and size of excess phases; the minimizing of segregation and the refinement of inclusion particle size; the generation of near-amorphous (homogeneous) structures; the ability to produce a variety of metastable intermetallic compounds; all these suggest a vast potential for structure modifications and property improvements. The first aim is to achieve rapid quenching (greater than about 10^3 or 10^4°C sec^{-1}) with pound lots of alloys to provide sufficient material for mechanical, chemical, and physical testing. The second aim is to select promising alloy systems. Author

N67-35353*# Pratt and Whitney Aircraft, East Hartford, Conn.

TURBINE BLADE SPECIMEN MATERIAL PROPERTIES

In its Methods for Predicting Thermal Stress Cracking in Turbine Stator or Rotor Blades 10 Jul. 1967 16 p (See N67-35350 21-32)

Graphical data are presented to depict the properties of the two specimen materials used to predict the life of the blade specimens tested. Densities of the test materials are 0.297 lb/cu in., and 0.0280 lb/cu in. The plots show proportional limit vs. temperature, 0.02% yield strength vs. temperature, ultimate tensile strength vs. temperature, dynamic Young's modulus vs. temperature, elongation and reduction of area vs. temperature, proportional limit vs. temperature, total strain range vs. cycles at various temperatures, expansion coefficient vs. temperature, specific heat vs. temperature, and thermal conductivity vs. temperature. Three strain specimen configurations were used, including one with holes, and one with slots. M.G.J.

N67-35355# Massachusetts Inst. of Tech., Cambridge. Dept. of Metallurgy.

SOLIDIFICATION OF IRON BASE ALLOYS AT LARGE DEGREES OF UNDERCOOLING Interim Report, Oct. 1, 1965–Sep. 30, 1966

T. Z. Kattamis and M. C. Flemings Sep. 1966 80 p refs

(Contract DA-19-020-AMC-0231(X))

(AMRA-CR-64-07/3; AD-654789)

Dendrite morphology and grain size were studied in bulk samples of iron and nickel base alloys undercooled up to 300 C. In the alloys studied, dendrite morphology gradually changes with increasing undercooling from the usual dendritic structure to a structure composed of cylindrical dendrite arms. At a critical undercooling of approximately 170 C in these alloys there is an abrupt transition to a fine grained structure of spherical morphology. TAB

N67-35484# Case Inst. of Tech., Cleveland, Ohio. Dept. of Metallurgy.
FORMATION OF BAINITE IN BETA BRASS
P. E. Repas (U.S. Steel Corp.) and R. F. Hehemann Jun. 1967 62 p refs
(Contract Nonr-1141(15))
(TR-6; AD-654728)

When quenched from the beta field alpha forms from beta brass in a slow, displacive manner analogous to the formation of bainite in steels. The decomposition product adopts a needle-like morphology at high temperatures and an internally faulted, plate-like morphology at low temperatures. Both forms develop over a narrow range of temperatures and exhibit similar growth rates. Within this transition region, needles nucleate at the edges of plates and also independently at beta grain boundaries and within the grains. Except at temperatures near the alpha + beta/beta solvus, growth rates are substantially higher than expected from a diffusion controlled growth model and microprobe studies suggest that the degree of solute partitioning becomes less severe as the reaction temperature is lowered. Author (TAB)

N67-35632# Beryllium Corp., Reading, Pa.
THE ECONOMICS OF BERYLLIUM APPLICATIONS
Lawrence F. Boland 5 Apr. 1967 15 p Presented at the Meeting of the Comm. on Beryllium Met., Washington, D. C., 5 Apr. 1967

Cost factors for beryllium, and market outlets for its use are discussed. Price projection curves for beryllium powder, sheet, rod, extrusions, and wire are depicted; and each form of the metal is discussed with respect to marketing costs. L.S.

N67-35622# Naval Research Lab., Washington, D. C.
ARPA COUPLING PROGRAM ON STRESS-CORROSION CRACKING Quarterly Report
E. P. Dahlberg, ed. Apr. 1967 44 p refs
(Contracts Nonr-610(09); Nonr-760(31); N00014-66-C0365; ARPA Order 878)
(NRL-MEMO-1775; QR-2; AD-654711)

A progress report of the research investigations being carried out on the problem of stress-corrosion cracking of high strength materials is presented. Work concerning physical metallurgy, surface chemistry, fracture mechanics, and characterization tests and translation related to stress-corrosion cracking is described. The materials being studied include high strength steels, titanium alloys, and aluminum alloys. Abstracts of recently published reports are included. TAB

N67-35635# Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucléaires.
STUDIES OF U–Pu–C–Ti COMPOUNDS [ETUDES DE COMPOSES U–Pu–C–Ti]
Claude Milet Mar. 1967 44 p refs In FRENCH
(CEA-R-3201)

The U–Pu–C–Ti compounds (5 to 20 at. % Ti) were to effect improvements in properties of U–Pu–C carbides and to extend the existence field of the (U, Pu)C phase. The Pu/(U+Pu) ratio was fixed to 15%. All the alloys were elaborated and cast in an arc furnace. A two-phase field (U, Pu)C + TiC exists which permits the avoidance of di- and sesquicarbides and the (U, Pu) phase. A eutectic between (U, Pu)C and TiC was found around 15 at. % Ti. Practically all of the Ti was in TiC form. Ti solubility in (U, Pu)C being less than 1 at. %. The most promising alloys were those containing two phases: (U, Pu)C + TiC. In comparison with the (U, Pu)C phase, Ti addition did not change the thermal expansion coefficients nor the thermal cycling behavior very much between 160 and 1000°C which was excellent. On the other hand atmospheric corrosion behavior was improved; compatibility with stainless steel was better; and thermal conductivity, calculated from electrical resistivity was enhanced. Author (NSA)

N67-35677# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
SCATTERING OF ENERGY DURING VIBRATIONS OF ELASTIC SYSTEMS [K VOPROSU O SVYAZI RASSEYANIYA ENERGII V MATERIALE S USTALOSTNOY PROCHNOST'YU]
V. T. Troshchenko 26 Apr. 1967 33 p refs Transl. into ENGLISH from Tr. Inst. Met. Akad. Nauk Ukr. SSR (Kiev), no. 4, 1963 p 149–158, 226–233
(FTD-MT-65-231; AD-655019)

Contents: Toward the question on connection of energy scattering in material with fatigue strength; and structural energy dissipation during vibrations of turbine blades. TAB

N67-35720# Technische Hochschule in Wien (Austria).
RARE EARTH-MANGANESE ALLOYS, THEIR PREPARATION, CRYSTAL STRUCTURES, PHASE DIAGRAMS, AND MAGNETIC PROPERTIES Technical Report, 1 Apr. 1962–30 Mar. 1966
Hans R. Kirchmayr and Franz Lihl Wright-Patterson AFB, Ohio, AF Mater. Lab., Jan. 1967 49 p refs
(Contract AF 61(052)-609)
(AFML-TR-66-366; AD-654653)

By the amalgam process, which consists of a heat treatment of amalgams and yields mercury-free alloys and intermetallic compounds, rare earth metal (RE Y, La, Ce, Pr, Nd, Sm, Gd, Dy, Ho, Er)-manganese intermetallic compounds have been prepared. The lattice spacings and the structures of the compounds REMn2, RE6Mn23, and REMn12 were determined. The phase diagrams of the systems Gd-Mn, Dy-Mn, Ho-Mn, and Er-Mn are given. By magnetic measurements in the temperature range from 80 to 1500K the magnetization, susceptibility, and the Bohr-magneton numbers of these compounds are evaluated. The magnetic behavior of these compounds can be understood by a mutual interaction of different ferrimagnetic states. Author (TAB)

N67-35836# Brookhaven National Lab., Upton, N. Y.
THE U.S. PROGRAM ON CORROSION BY LIQUID Na
John R. Weeks [1966] 5 p
(Contract AT(30-2)-GEN-16)
(BNL-11265) CFSTI: HC$3.00/MF$0.65

Information of a preliminary nature on research programs conducted at three U. S. laboratories on corrosion of metals and alloys by liquid Na are given. Results of previous programs have been presented elsewhere and the current report discusses primarily the direction of effort in the U.S. NSA

N67-35853# California Univ., Berkeley. Lawrence Radiation Lab.
ELECTRON MICROSCOPIC STUDY OF MARAGING STEEL
I-lin Cheng (M.S. Thesis) Jan. 1967 44 p refs
(Contract W-7405-ENG-48)
(UCRL-17334) CFSTI: HC$3.00/MF$0.65

A careful examination of one system of maraging steels based on Ni–Co–Ti–Fe has been done primarily using electron microscopy, in an attempt to delineate the hardening mechanism in terms of the substructural changes. The results indicated that precipitation hardening is the main strengthening mechanism. Upon plastic deformation, the specimens exhibited a brittle failure under typical maraging treatments which gave microstructures having grain and/or martensite sub-boundary precipitation. Identification of precipitates by electron diffraction and electron beam microprobe indicated that they were a (Ni–Ti) intermetallic compound, probably, Ni_3Ti. The orientation relationship of them with the matrix is $(001)_p \| (110)_\alpha$, $[2\bar{1}\bar{1}0]_p \| [\bar{1}\bar{1}1]_\alpha$. An analysis was made using both the Orowan and Ansell models to account for the initial yield stress of this alloy. It was concluded that the Ansell model is the controlling one. Author (NSA)

N67-35941# Case Inst. of Tech., Cleveland, Ohio. Dept. of Metallurgy.
INTERFACE MOTION IN DISPLACIVE PHASE TRANSFORMATIONS Final Report, 1962–1967
R. F. Hehemann Jul. 1967 17 p refs
(Contract Nonr-1141(15))
(AD-655122)

The report reviews the results of a study of interface motion in displacive phase transformations conducted during the period 1962 to 1967. The structure, morphology and growth kinetics of displacive reactions in beta brass are compared with the corresponding features of the bainite reaction in steel. Detailed results of the study have been presented in a series of publications and graduate theses. A bibliography is included. Author (TAB)

N67-35986*# Aluminum Co. of America, New Kensington, Pa. Chemical Metallurgy Div.
INVESTIGATION OF THE STRESS-CORROSION CRACKING OF HIGH STRENGTH ALUMINUM ALLOYS Final Report, 6 May 1963–6 Oct. 1966
D. O. Sprowls, B. W. Lifka, D. G. Vandenburgh, R. L. Horst, and M. B. Shumaker 6 Oct. 1966 195 p refs
(Contract NAS8-5340)
(NASA-CR-88110) CSCL 11F

The necessity for developing reliabile stress corrosion test methods is discussed in relation to the selection of test procedures, specimens, loading methods, and environments that will produce accurate data on the failure mode, relative ratings of materials, and service performance. Several high strength aluminum alloys were investigated in various natural environments and laboratory media to determine their resistance to stress corrosion cracking. The 3.5% NaCl alternate immersion, and an acidified (pH 3) 5% NaCl intermittent spray are considered promising as accelerated test techniques. An evaluation of surface treatments and coatings showed that none offered complete protection. Procedures are detailed on an accelerated electrochemical test for evaluating stress corrosion resistance of 2219 alloy in less than an hour. Stress corrosion tests were also conducted on TIG welded butt joints of experimental high strength weldable alloys, loaded by bending and tension methods and exposed to several environments. It was found that direct tension loading caused more rapid failure of susceptible materials and at lower stresses than loading in bending. M.G.J.

N67-36041# TRW Systems Group, Redondo Beach, Calif.
RESEARCH INVESTIGATION OF CORROSION-RESISTANT MATERIALS FOR ELECTROCHEMICAL CELLS Final Report, Jan. 1966–Jan. 1967
Jan. 1967 97 p refs
(Contract DA-44-009-AMC-1452(T))
(TRW-05660-6002-R000; AD-654807)

The compatibility of highly corrosion-resistant metals and alloys with molten salt and hot phosphoric acid electrolyte systems was studied. Probes suitable for use with the electrical-resistance method in molten salt electrolytes were developed. The probes made from 304 and 316 stainless steels were tested in KCl and KCl-NaCl at temperatures of 820 C and 700 C, respectively. The probes of 316 stainless steel showed fair reproducibility in corrosion rates when the probes were prepared and tested under similar conditions. The electrical-resistance method was found to be equally applicable for evaluating material compatibility in hot, concentrated phosphoric acid. The pure metals Ta, Ni, and W, as well as Ni- and W-based alloys, were investigated. Ta and Ta-10W alloy exhibited corrosion rates less than 1 mpy. Pure W and Hs alloys, W-25Re and 40Mo-30Re-30W, were also resistant to concentrated phosphoric acid with corrosion rates between 1 to 6 mpy. The results also indicated the potential gains that can be achieved by exploring a large number of alloy system and its composition range. The diffusion block concept of preparing a large number of alloy combinations in a systematic manner was thus conceived and tested. Author (TAB)

N67-36081*# Stanford Research Inst., Menlo Park, Calif.
STUDY OF GROWTH PARAMETERS FOR REFRACTORY CARBIDE SINGLE CRYSTALS Final Report, 1 Mar. 1964–30 Jun. 1967
R. W. Bartlett and F. A. Halden 30 Jun. 1967 109 p refs
(Contract NASr-49(19))
(NASA-CR-88354) CFSTI: HC $3.00/MF $0.65 CSCL 11F

The feasibility of growing single crystals of the most refractory metal carbides from their melts and from liquid metal solutions was investigated. Boules produced by an ac arc-heated Verneuil technique yielded cut single crystals of tantalum monocarbide and hafnium monocarbide. Crystals of tantalum monocarbide up to 1 inch long were obtained. Spontaneous nucleation of new grains during crystal growth usually prevented the harvesting of crystals longer than 0.4 inch. Mixed tantalum carbide–hafnium carbide solid solution crystals large enough for physical property measurements were not obtained because of excessive nucleation during growth. The carbon content of tantalum monocarbide crystals was lowered to 43–46 atomic percent by vaporization of carbon during crystal growth. Further carbon depletion was prevented by using a hydrogen–argon gas mixture. The elastic constants of $TaC_{0.9}$ crystals were determined by an ultrasonic method. Verneuil melt growth using induction plasma heating was unsuccessful. Liquid metal solution growth did not yield crystals larger than 0.2 mm. Author

N67-36159*# Solar, San Diego, Calif.
DEVELOPMENT OF COATINGS FOR TANTALUM ALLOY NOZZLE VANES Final Report, 1 May 1965–31 Jan. 1967
R. T. Wimber and A. R. Stetson Jul. 1967 142 p refs
(Contract NAS3-7276)
(NASA-CR-54529; RDR-1396-3) CFSTI: HC $3.00/MF $0.65 CSCL 11F

A group of silicide coatings developed for the T222 tantalum-base alloy have afforded over 600 hours of protection at 1600° and 2400°F during cyclic exposure in air. These coatings were applied in two steps. A modifier alloy was applied by slurry techniques and was sintered in vacuum prior to siliciding by pack cementation in argon. Application of the modifier alloy by pack cementation was found to be much less effective. The addition of titanium and vanadium to molybdenum and tungsten yielded beneficial modifier alloys, whereas the addition of chromium showed no improvement. After siliciding, the 15 Ti–35W–15V–35Mo modifier alloy exhibited the best performance; one sample survived 1064 hours of oxidation at 2400°F. This same coating was the only coating to reproducibly provide 600 hours of protection at both 1600° and 2400°F. The slurry coatings were also shown to protect the Cb752 and D43 columbium-base alloys. Author

N67-36191# United Kingdom Atomic Energy Authority, Harwell (England). Information Branch.
BASIC TYPES OF DEFORMATION MICRO-CONTOURS APPEARING ON THE SURFACE OF COMMERCIAL IRON TEST-PIECES DURING FATIGUE TESTING UNDER HEATING *IN VACUO*
M. G. Lozinskii and A. N. Romanov Jun. 1967 15 p refs
Transl. into ENGLISH from Mashinovedenie (USSR), no. 3, 1965 p 56–65
(AERE-TRANS-1070) CFSTI: HC $3.00/MF $0.65

Equipment for determining the microstructural features of materials subjected to fatigue testing under application of heat is described. The new equipment makes possible the study of microstructure and kinetics of failure of metals and alloys under heating in vacuo from 20 to 1200°C while flat test-pieces are subjected to bending. An external view of the IMASH-10 equipment is included. Studies showed that the deformation microcontours that form on the polished surface of the test piece under the influence of alternating load are characterized by their wide diversity. This is due to many factors that affect the course of the

deformation processes but primarily to conditions of thermal and mechanical loading. An attempt was made to classify the basic types of microcontour in commercial iron, which has a body-centered cubic crystal lattice, at test temperatures of 20 to 800°C. S.P.

N67-36199# Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.
FRACTURE MECHANICS EVALUATION OF REACTOR VESSEL STEELS Quarterly Progress Report, Period Ending Mar. 31, 1967
L. F. Cochrun Apr. 1967 34 p
(Contract AT(30-1)-3677)
(WCAP-3677-3; EURAEC-1829) CFSTI: HC $3.00/MF $0.65

Construction and testing of the calibration capsule was completed. Temperature uniformity, with and without gas cooling and resistance heating, was unsatisfactory. The design was modified on the basis of experimental results and a second calibration capsule is to be built and tested. The materials to be used, including a Ni-modified Mn–Mo steel and a European forging grade steel, were fabricated, and tensile properties of both steels were evaluated at −250 to 600°F. NSA

N67-36223*# Lockheed Missiles and Space Co., Sunnyvale, Calif.
WELD-ALLOY
John C. McDonald and J. C. Olsen *In* JPL 2d Aerospace Mech. Symp. 15 Aug. 1967 p 155–162 ref (See N67-36203 21-31)

The weld-alloy research described verifies the hypothesis that an overlaid weld of specific metal would produce a predictable alloy with a given base metal, and that the resultant weld-alloyed seam would have predictable mechanical properties. The intended use of this technique was development of peripherally weld-alloyed removable areas of stressed-skin vehicle structure. Laboratory tests to indicate weldability, alloying tendencies, tensile strengths, and susceptibility to bending and shock were performed. As a result of these investigations, it is concluded that predictable alloying and mechanical properties were indicated. It is felt that considerable research will have to be done to develop production techniques. Author

N67-36230*# National Aeronautics and Space Administration, Washington, D. C.
X-RAY STUDY OF THE COMPONENT ATOMIC SCATTERING AND STRUCTURAL DEFECTS OF TITANIUM CARBIDE [RENTOGENOGRAFICHESKOYE ISSLEDOVANIYE ATOMNOGO RASSEYANIYA KOMPONENTOV I FEFEKTNOSTI STRUKTURY KARBIDA TITANA]
M. P. Arbuzov and B. V. Khayenko Nov. 1966 9 p refs Transl. into ENGLISH from Poroshkovaya Met., Akad. Nauk Ukr. SSR (Kiev), v. 6, no. 3, 1966 p 64–70
(NASA-TT-F-10426) CSCL 11F

The method of analysis of the intensity of the diffraction spectrum of the titanium carbide line in Mo–k_α radiation and photographic recording of reflections were used to determine the f-curves of Ti and C in TiC. It is shown that when sin $\theta/\lambda > 0.65$ the atomic scattering factors of Ti and C in TiC agree with the available computed data for neutral isolated Ti and C atoms. With lower values of sin θ/λ deviations from the computed data are observed. It is assumed that these deviations are due to change in the states of Ti and C atoms during formation of titanium carbide. The defects in TiC structure computed from values obtained with sin $\theta/\lambda \geq 0.65$ agree with the results of chemical analysis. Author

N67-36235* Stanford Research Inst., Menlo Park, Calif.
THE RESULTS OF LONG-TERM STORAGE TESTS FOR COMPATIBILITY OF NITROGEN TETROXIDE WITH VARIOUS SPACECRAFT MATERIALS
R. F. Muraca and J. S. Whittick 15 May 1967 104 p refs Prepared for JPL *Its* Spec. Rept.-2
(Contracts NAS7-100; JPL-951581)
(NASA-CR-88121) CSCL 11F

The results of corrosion tests are reported for various metallic and ceramic specimens which were stored in sealed capsules with nitrogen tetroxide at 110°F for periods of 1-1/2 to 3 years. It was found that the least corroded materials are titanium alloys, iron alloys, cobalt alloys, some nickel alloys, tantalum, and alumina. Corroded materials are: molybdenum, magnesium, and some aluminum and nickel alloys. Chemical analysis of the nitrogen tetroxide included determination of water content by a new gas chromatographic procedure, of nitric oxide by a spectrophotometric method, and of chloride content and residue by standard analytical procedures. Examination of solid specimens included determination of change in weight, microphotographic studies of corroded or degraded surfaces, x-ray examination of corrosion products. Gages and fittings used with the storage capsules were also examined. The results of the chemical and metallurgical determinations are given in tabular form, supplemented by photographs of the surfaces of stored materials. Author

N67-36239# General Dynamics Corp., San Diego, Calif. General Atomic Div.
A RESEARCH PROGRAM ON THE EFFECT OF SUBSTRUCTURE ON THE IRRADIATION STABILITY OF ASTM A302 GRADE B STEEL
T. A. Trozera and P. W. Flynn 12 Apr. 1967 17 p refs
(Contract AT(04-3)-167)
(GA-7895; EURAEC-1839) CFSTI: HC $3.00/MF $0.65

The four ambient temperature irradiation capsules were opened, and temperature and flux monitors were examined. The out-of-cell Charpy impact machine was instrumented, and several successful tests were made. The elevated temperature (290°C) irradiation capsule was assembled, inserted in the LITR, and removed with a fluence of about 9×10^{18} n/cm^2. Author (NSA)

N67-36293# Oak Ridge National Lab., Tenn.
EFFECT OF TITANIUM ADDITIONS ON THE STRESS-RUPTURE PROPERTIES OF TYPE 304 STAINLESS STEEL
E. E. Bloom Jun. 1967 24 p refs
(Contract W-7405-ENG-26)
(ORNL-TM-1807) CFSTI: HC $3.00/MF $0.65

The effects of small additions of Ti on the stress-rupture properties of types 304 and 304L stainless steel were determined. Stress-rupture tests were performed on rod specimens at 704 and 815°C. For tests in the solution-treated condition, Ti increased the rupture life and decreased the minimum creep rate by approximately an order of magnitude. This increase in strength was attributed to the locking of dislocations during creep and was demonstrated by the appearance of small precipitates on dislocations. When C was removed from solution by prior precipitation, dislocation locking did not occur and the minimum creep rate was increased. The Ti-bearing steels failed by a mixture of transgranular and intergranular fracture whereas type 304 stainless steel fractured intergranularly. Author (NSA)

N67-36296# MSA Research Corp., Evans City, Pa.
EFFECT OF HIGH TEMPERATURE SODIUM ON THE MECHANICAL PROPERTIES OF CANDIDATE ALLOYS FOR THE LMFBR PROGRAM Quarterly Progress Report, Jan.–Mar. 1967
R. C. Andrews and K. R. Barker May 1967 44 p
(Contract AT(11-1)-765)
(MSAR-67-79) CFSTI: HC $3.00/MF $0.65

Developments are reported for studies on: effects of high temperature Na on austenitic and ferritic steels; mechanical property testing; system operation and loop studies; sorption of C by Ni, Ni

alloys, stainless steels, and steels; design of analytical magnetic traps; loop design for mechanical property testing of LMFBR structural materials; and design of high temperature-liquid metal environment extensometer. NSA

N67-36353# Iowa State Univ. of Science and Technology, Ames. Dept. of Metallurgy.
PROBLEMS AND PROGRESS IN METALLURGY OF THE RARE EARTHS
Earl Gschneider, Jr. *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 403–404 (See N67-36303 21-06)

A summary of chemical, physical, and mechanical problems related to the metallurgy of rare earths is presented; with emphasis placed on the difficulty of obtaining high purity metals. It is because of this lack of purity that most of the rare earth phase diagrams prepared prior to 1945 are considered incorrect. It is also noted that of the 1160 possible rare earth binary alloy systems only a small percentage have been established, a fact which further emphasizes the need for accurate phase relationships. Note is also made of the lack of information on the modes of plastic deformation, slip systems, point vacancies, various defects, and workability of rare earths. M.W.R.

N67-36354# Los Alamos Scientific Lab., N. Mex.
SELF-IRRADIATION EFFECTS IN A CERIUM ALLOY CONTAINING 15 AT.% PLUTONIUM
R. O. Elliott, W. N. Miner, and F. W. Clinard, Jr. *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 405–415 refs Sponsored by AEC (See N67-36303 21-06)

Four samples of an α-phase cerium alloy (85 at.% Ce-15 at.% Pu) were stored at 20°K for 1076 hr. The plutonium used in making the samples was variably enriched with Pu^{238} isotope to provide four different levels of irradiation. Accumulation of lattice damage due to the alpha activity of plutonium was followed by periodically measuring the electrical resistivities of the samples during storage at low temperature. Annealing of damage was then followed from 20° to 350°K by the isochronal method. Results are discussed in terms of the nature of the lattice damage. Author

N67-36355# Oak Ridge National Lab., Tenn. Metals and Ceramics Div.
A METALLOGRAPHIC STUDY OF THE ALLOTROPIC PHASE TRANSFORMATIONS IN CERIUM
C. C. Koch and C. J. Mc Hargue *In its* 6th Rare Earth Res. Conf. [1967] p 416–427 refs Sponsored by AEC (See N67-36303 21-06)

Some aspects of the phase transformations in cerium were studied by using metallography. The percent dhcp formed by athermal transformation vs temperature as determined by X-ray diffraction has been confirmed by quantitative metallography. The influence of plastic deformation on the transformation has been studied by deforming cerium specimens at temperatures above and below M_s. Metallography definitely indicates that deformation promotes the fcc → dhcp reaction. A M_d temperature has been determined. It appears that a tensile component of deformation is necessary for the fcc → dhcp transformation which may explain the conflicting evidence of the effect of deformation on this transformation. The influence of deformation on subsequent athermal transformation and reversion has been studied. The morphology of the fcc ⇄ dhcp transformation has been examined and lattice relationships have been inferred. Author

N67-36356# Iowa State Univ. of Science and Technology, Ames. Inst. for Atomic Research.
THE YTTRIUM–LEAD ALLOY SYSTEM
O. N. Carlson, F. A. Schmidt, and D. E. Diesburg *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 428–439 refs Sponsored by AEC (See N67-36303 21-06)

The yttrium-lead alloy system was investigated by thermal analysis, microscopic and X-ray methods. An inverse peritectic reaction occurs on the yttrium-rich end of the system and there is a eutectic at 14 at.% Pb and 1240°C between yttrium and the compound, Y_5Pb_3, which melts congruently at 1760°C. The lead-rich side of the system consists of a series of peritectic reactions associated with three additional compounds. From X-ray diffraction data and microscopic evidence, the compositions of these compounds were determined to be Y_5Pb_4, YPb_2 and YPb_3. Horizontals corresponding to the decomposition temperatures of these compounds occur at 1650, 945 and 740°C, respectively. Author

N67-36357# Iowa State Univ. of Science and Technology, Ames. Inst. for Atomic Research.
YTTERBIUM–LEAD AND EUROPIUM–LEAD SYSTEMS
O. D. Mc Masters *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 440–448 refs (See N67-36303 21-06)

Differential thermal, metallographic and X-ray parametric methods were used to establish the ytterbium- and europium-lead phase diagrams. The terminal solid solubilities, eutectic points, liquidus curves and horizontal reaction temperatures of these systems were determined. The intermetallic compounds Yb_2Pb, YbPb, $YbPb_3$, Eu_2Pb, EuPb and $EuPb_3$ melt congruently. Both YbPb and EuPb compounds exhibit a polymorphic transformation. Compounds Yb_5Pb_3 and Eu_5Pb_3 form a peritectic reaction. Lattice parameters values and crystal structure data are given for most of these compounds. The valency characteristics of the rare-earth component in these alloys are discussed. The crystal chemistry of these compounds are compared to those of the alkaline-earth and trivalent rare-earth compounds. Author

N67-36358# Missouri Univ., Rolla. Dept. of Metallurgical Engineering.
SYNTHESIS AND IDENTIFICATION OF INTERMETALLIC COMPOUNDS IN THE Fe–Ho SYSTEM
T. J. O'Keefe, G. J. Roe, and W. J. James *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 449–451 *Its* Graduate Center for Mater. Res. Contrib. no. 23 (See N67-36303 21-06)

The intermediate pheses in the iron–holmium system were investigated by means of X-ray diffraction, electron microprobe analysis, and metallographic techniques. The phases which were either definitely or tentatively identified were $HoFe_2$, $HoFe_3$, Ho_6Fe_{23}, $HoFe_5$, and Ho_2Fe_{17}. The lattice parameters were determined by the Straumanis technique using Fe Kα radiation. Work in progress is also discussed. Author

N67-36359# Mound Lab., Miamisburg, Ohio.
THE CERIUM–IRON AND CERIUM–NICKEL BINARY SYSTEMS
J. M. Gebhart, III, D. E. Etter, and P. A. Tucker *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 452–457 refs (See N67-36303 21-06)
(Contract AT(33-1)-GEN-53)

The phase equilibria in the cerium–iron and cerium–nickel binary systems were investigated by differential thermal analysis, thermal analysis, metallography and x-ray diffraction, and a phase diagram was developed for each binary system. Both of the systems have been reported in the literature; however, the present work shows considerable disagreement with the earlier diagrams in the liquidus temperatures as well as the temperatures and compositions of the binary invariant points. Many of these discrepancies are probably the result of differences in purity of the cerium metal used in the studies. The current studies were conducted with cerium which melted at 804°C and had a reported purity of 99.9%. Author

N67-36360# Denver Research Inst., Colo.
STUDIES OF THE SAMARIUM–GADOLINIUM SYSTEM
A. S. Yamamoto and C. E. Lundin *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 458–468 refs (See N67-36303 21-06)
(Contract AT(11-1)-1298)

Phase relations in the Sm–Gd alloy system were established by collective analysis of various data. These data were obtained from microscopic examination, X-ray diffraction analysis, thermal analysis, density and microhardness measurements as well as Knudsen-effusion experiments. Thermodynamic activities of samarium in the hexagonal close-packed phase in the temperature range from 1073 to 1373°K were calculated from the vapor-pressure data obtained in the Knudsen effusion studies. A plot of activities versus mole fraction shows a negative deviation from ideality, or a tendency for unlike atom attraction. The phase equilibria exhibit complete miscibility both in liquid and solid. The characteristics of the two component metals are very similar, thus favoring the formation of such continuous solutions. Author

N67-36361# Academy of Sciences (USSR), Moscow. A. A. Baikov Metallurgical Inst.
THE ALLOYS OF SAMARIUM WITH GADOLINIUM AND CERIUM
E. M. Savitsky, V. F. Terehova, and R. S. Torchinova *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 469–470 (See N67-36303 21-06)

The Sm–Ce, Sm–Gd binary systems have been investigated by means of microstructural, X-ray and thermal analysis. The hardness and magnetic susceptibility vs temperature curves were built in the temperature range −183 + 25°C. In the Sm–Gd system a complete solid solubility of high temperature b.c.c. modifications of samarium and gadolinium and a wide series of solid solutions between low temperature h.c.p. modification of gadolinium and rhombohedrical of samarium have been found. The two phase region existed between 59–75 w/o Gd. No intermetallic compounds were found in this system. Author

N67-36442# Iowa State Univ. of Science and Technology, Ames.
REACTOR MATERIALS DEVELOPMENT Quarterly Report, Jan.–Mar. 1967
A. F. Voigt, ed. Mar. 1967 26 p refs
(IS-RD-9) CFSTI: HC $3.00/MF $0.65

Developments are reported for studies on: metal preparation and purification for Th, Y, and other reactor metals; phase diagrams for rare earth, refractory metal, and other reactor materials systems; mechanical behavior and forming of reactor materials; methods for single crystal preparation; and properties of materials at high temperature. NSA

N67-36462* Scientific Translation Service, La Canada, Calif.
CORROSION RESISTANCE OF Ti IN HOT CONCENTRATED CHLORIDE SOLUTIONS
Takaaki Shimose and A. Takamura Washington, NASA, Aug. 1967 11 p refs Transl. into ENGLISH from Nihon Kinzoku Gakkai-Shi, v. 29, no. 4, 1965 p 416–421
(Contract NASw-1496)
(NASA-TT-F-11177) CSCL 11F

An investigation was carried out on the corrosion resistance of titanium in hot concentrated chloride solutions, in order to study the cause of the unusual crevice corrosion encountered in chemical plants and to find preventive measures. The weight losses during the corrosion test and potentiostatic polarization were measured in various chloride solutions at or near the boiling temperatures. Stability of passivity on titanium was found to be dependent on the chloride concentration: the domain of passivity decreased with increase of the chloride and hydrogen ion concentrations, and the passivity became unstable gradually. And the tendency to activate from the passive state was accelerated by the elevation of temperature. For instance, while no corrosion was observed in the neutral 25% NaCl solution, a severe general corrosion occurred in the acidic 33% $AlCl_3$ solution, and even in the case of a neutral solution, pitting corrosion occurred in such high chloride concentration solutions as 61% $CaCl_2$ and 66% $ZnCl_2$ solutions. Author

N67-36821# Oak Ridge National Lab., Tenn.
TIME-DEPENDENT HARDNESS OF SOFT METALS
Jorgen Larsen-Badse Apr. 1967 16 p refs Presented at the Ann. Meeting of the Am. Inst. of Mining, Met., and Petrol. Engr., Los Angeles, 19–23 Feb. 1967
(Contract W-7405-ENG-26)
(ORNL-TM-1771; CONF-670206-5) CFSTI: HC $3.00/MF $0.65

Room-temperature Vickers hardness tests were carried out on In, Sn, and Pb for times of loading between 1 and 60,000 sec and with applied loads in the range 500 to 1600 g. The applied load was found to have no influence on the time-hardness relation within a wide time range. The hardness decreased with increased time of loading according to $t \propto H^{-\gamma}$. For long times of loading the hardness deviated from this relation towards lower values. The results are explained on the basis of previous experiments on creep under flat punches for the same materials. It is shown that $\gamma = 2n+1$, where n is the exponent of the uniaxial creep relation $\dot{\varepsilon} \propto \sigma^n$. Author (NSA)

N67-36829# Virginia Polytechnic Inst., Blacksburg. Dept. of Metals and Ceramic Engineering.
THE RELATIONSHIP OF NITROGEN CONTENT OF AUSTENITIC STAINLESS STEELS TO STRESS CORROSION Quarterly Report, Jan. 1–Mar. 31, 1967
Thomas B. Cox Mar. 1967 32 p refs
(Contract AT(40-1)-3208)
(EURAEC-1838; QR-11) CFSTI: HC $3.00/MF $0.65

Studies on the solid solubility of N in AISI Type 304 stainless steel were continued. Determination of the solid solubility limit was made at 566, 593, 954, and 981°C; thus permitting the construction of a plot of N solid solubility as a function of temperature in type 304 stainless steel. Also, the thermodynamic quantities for the solution reaction were calculated at these temperatures. Results of the heat treatment study aimed at producing a supersaturated solid solution of N in type 304 stainless steel at room temperature are included. NSA

18 MATERIALS, NONMETALLIC

Includes corrosion; physical and mechanical properties of materials (e.g., plastics); and elastomers, hydraulic fluids, etc. For basic research see: 06 Chemistry. For related information see also: 17 Materials, Metallic; 27 Propellants; and 32 Structural Mechanics.

N67-35304*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
MATERIALS
Harrison Allen, Jr. *In its* Aerospace Related Technol. Conf. for Ind. and Com. 25 May 1967 p 1–15 (See N67-35303 21-15)

The development of materials for extremely high and low temperatures, and the effects of these temperatures on mechanical and chemical properties are reviewed. The use of special

silicate-base inorganic paints for corrosion resistance is mentioned. A multilayer insulation made of mylar plastic coated with a thin layer of aluminum is described, and aerospace and industrial applications are indicated. Improvements in reinforced composites are illustrated by fiber glass reinforced plastics and reinforcing with metal fibers and whiskers. Superalloy metallurgy and the use of tungsten alloys as die materials are summarized. N.E.N.

N67-35367*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
DIELECTRIC STRENGTH OF RIGID URETHANE FOAM
J. Moacanin, J. Farrar, and I. N. Einhorn (Wayne State Univ.) 1 Sep. 1967 19 p refs
(Contract NAS7-100)
(NASA-CR-87986; JPL-TR-32-1155) CFSTI: HC $3.00/MF $0.65 CSCL 11I

Cellular plastics are being considered as lightweight encapsulants for electronic packaging in space applications. This study was carried out to assess the importance of the various parameters pertaining to the electrical properties of foams and, thus, provide a basis for the prediction of the life-time of foam-packages operating in space environment. This report deals mainly with the dielectric breakdown foam structure relationships. It was found that the dielectric strength of a foam will be improved by the following characteristics: (1) uniform cells and minimum void content, (2) small and symmetric cells, (3) gas pressure and type of gas (flurorcarbons), (4) thick and stress-free window, and (5) density (between 6 and 10 lb/ft^3). Author

N67-35482# Little (Arthur D.), Inc., Cambridge, Mass.
THERMAL RADIATION PROPERTIES OF SOME POLYMER BALLOON FABRICS
I. W. Dingwell Jun. 1967 53 p refs
(Contract Nonr-3164(00))
(C-82944; TR-6; AD-654744)

As the absorption of solar and earth atmosphere thermal radiation is an important factor in the vertical motion of high altitude balloons, the thermal radiation properties of the thin films that compose balloon fabrics must be determined. This report presents the results of property measurements made with spectrophotometer, emissometer, and thermal radiation measuring equipment. The films considered were polyethylenes, mylar composites and other fabrics. Author (TAB)

N67-35552*# General Electric Co., Philadelphia, Pa. Missile and Space Div.
PLANETARY VEHICLE THERMAL INSULATION SYSTEMS, PHASE I Summary Report
S. J. Babjack, R. W. Carr, A. D. Cohen, L. V. Dudley, C. S. Lankton et al 3 Mar. 1967 195 p refs
(Contract JPL-951537)
(NASA-CR-88009; Doc.-67SD4289) CFSTI: HC $3.00/MF $0.65 CSCL 11D

This program seeks to determine insulation requirements and superinsulation techniques for planetary vehicles of the Voyager spacecraft/capsule size class. The insulation system should limit loss of internal energy to acceptable values and should protect the vehicle from solar energy at Earth and Mars intensity. Tests and analyses were conducted which aimed at the selection of insulation materials and establishment of thermal requirements. Several superinsulation materials were tested for absorptivity, emissivity, weight loss, and thermal conductivity. Relative to possible sterilization requirements, candidate insulation materials were exposed to ethylene oxide and dry heat sterilization cycles to evaluate their compatibility with these environments. Evaluated were also the effects of rapid depressurization on insulation blankets of varying sizes. Prior to exposing samples to simulated heat flux from a quartz lamp bank, the samples were placed in a combined effects facility and subjected to ultraviolet exposure and proton bombardment. Thermal analyses of insulation requirements were performed for five mission phases for the spacecraft and seven mission phases for the capsule. The feasibility of thermal scale modeling of the insulation system was studied. Based on the results from these studies, a selection of insulation materials, joints, maximum blanket sizes, and methods of attachment is recommended. K.W.

N67-35558# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
METHOD OF OBTAINING AN ELECTRICAL INSULATING IMPREGNATING COMPOUND [SPOSOB POLUCHENIYA ELEKTROIZOLYATSIONNOGO PROPITOCHNOGO KOMPAUNDA]
A. G. Prelkova, A. V. Khval'kovskiy, O. M. Il'ina, and A. P. Kuznetsov 31 Jan. 1967 6 p Transl. into ENGLISH from Russian Patent no. 170649 (Appl. no. 879650/23-5, 31 Jan. 1964) 2 p
(FTD-HT-66-710; AD-654645)

The patent describes a preparative method for an electrical-insulation impregnating compound, involving the mixing of epoxy resin, endic anhydride, polyester-acrylate (e.g., MGF-9 or TGM-3) and a radical polymerization initiator. To obtain a low-viscosity compound which is stable at ordinary temperatures, the epoxy resin is partly precured with the endic anhydride with heating. TAB

N67-35581# California Univ., La Jolla. Dept. of the Aerospace and Mechanical Engineering Sciences.
ON ELASTIC, WORKHARDENING SOLIDS
S. Nemat-Nasser Jul. 1967 27 p refs
(Contract N00014-67-A-0109-0003)
(TR-10; AD-655104)

A set of integral equations is established for the rate of change of the stress field that corresponds to a given rate of loading from a given elasto-plastic state in an elastic, workhardening solid. Approximate methods are developed for the numerical solution of these integral equations. Author (TAB)

N67-35601# Army Materials Research Agency, Watertown, Mass.
SURFACE AREA EFFECTS ON THE OXIDATION KINETICS OF PYROLYTIC GRAPHITE
Milton Levy Jun. 1967 16 p refs
(AMRA-TR-67-20; AD-654984)

The oxidation kinetics of pyrolytic graphite was studied as a function of temperature, air velocity, and surface area. The transition temperature between chemical and diffusion control may be significantly increased or decreased by decreasing or increasing the surface area of pyrolytic graphite. Kinetic theory calculations showed that the maximum reaction rate in the diffusion-controlled region is 50,000 times the observed rate for specimens having the smallest surface area. Author (TAB)

N67-35637# Melpar, Inc., Falls Church, Va.
STUDY OF GRAIN BOUNDARIES IN IONIC BONDED SOLIDS Final Report
A. D. McMaster, N. Fuschillo, and F. Ordway Jun. 1967 9 p refs
(Contract DA-31-124-ARO(D)-377)
(AROD-5727-5-MC; AD-654775)

The program entitled Study of Grain Boundaries in Ionic Bonded Solids, conducted over a two-year period, has been directed toward: (a) A systematic investigation of the substructure and mechanical strength of twist, tilt, and mixed orientations in bicrystals of NaCl, MgO and other materials; and (b) A study of the mechanical breakdown in polycrystalline samples of the above materials to determine the role of grain boundary misorientation in crack initiation and propagation. Author (TAB)

N67-35678# Naval Ordnance Lab., White Oak, Md. Chemistry Research Dept.
CONSTRUCTIVE THERMAL DEGRADATION OF EPOXIDE RESINS CURED WITH SEVERAL NOVEL BRIDGED DIELS–ALDER ANHYDRIDE ADDUCTS
Gerald J. Fleming 1 Jun. 1967 52 p refs
(NOLTR-67-40; AD-654391)

The synthesis of several novel bridged Diels-Alder anhydride adducts, useful as curing agents for epoxide resins, is reported. The effect of these adducts on the thermal stability and ablative performance of epoxide resin systems is shown. The concept of controlled constructive thermal degradation for ablative systems is discussed in relation to these adducts. Excellent ablative performance was obtained with these systems employing Refrasil, Pluton B-1, and graphite fabric reinforcements. Char rates of the epoxide systems were found to be the same or lower than those of phenolics, while the thermal conductivity was 2 to 3 times lower than that of the phenolics. Author (TAB)

N67-35683# Burke Research Co., Pompano Beach, Fla.
NITRILE ELASTOMER–NYLON LAMINATES INCLUDING BARRIER FILMS Interim Technical Report, Jul. 6, 1966–Jan. 14, 1967
O. W. Burke, Jr. and B. P. Hunt 27 Jan. 1967 42 p
(Contract DA-44-009-AMC-1073(T))
(AD-654790)

Laminates in which 2-3 mil pre-formed nylon films were sandwiched between layers of nylon fabric coated with butadiene-acrylonitrile copolymer (NBR). Adhesion of sulfur cured nitrile compounds to both fabric and film was strong and water-resistant provided that both fabric and film had been pre-treated with an aqueous RFL dispersion of resorcinol-formaldehyde resin and elastomer latex. Laminates consisting of thin layers of fluoroelastomer barrier films sandwiched between layers of RFL-treated nylon fabric, coated on the outside with NBR. Fluoroelastomer-nylon bonds, showed acceptable initial peel strength and excellent resistance to water. The initial adhesion of polyurethane barrier films to RFL-treated nylon was very strong, and the peel strength after water immersion was often still good. However, the polyurethane compound was noticeably deteriorated by water. Also the tear strength of nylon so coated was comparatively poor. TAB

N67-35697# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
OPTICAL GLASS [OPTICHESKOYE STEKLO]
G. T. Petrovskiy 24 Feb. 1967 4 p Transl. into ENGLISH from Russian Patent no. 170152 (Appl. no. 879809/29-14, 3 Feb. 1964) 1 p
(FTD-HT-66-721/1+4; AD-654647)

The patent describes an optical glass which contains SiO2, B2O3, GA2O3, NA2O, LI2O. A noncrystallizing glass with shortened partial dispersion in the blue portion of the spectrum is produced by using (in wt %): SiO2--30-60; B2O3--less than 12; GA2O3--30-40; NA2O--less than 8; LI2O--less than 5; and in addition BaO and ZnO--2-10. TAB

N67-35746 Nuklearni Institut Jozef Stefan, Ljubljana (Yugoslavia).
THE INFLUENCE OF ATMOSPHERE ON SINTERING HIGH SURFACE AREA URANIUM DIOXIDE
D. Kolar, B. S. Brcic, B. Zatler, and V. Marinkovic Apr. 1967 15 p refs
(NIJS-R-501)

The influence of reducing and oxidizing atmosphere on sintering uranium dioxide powders with different specific surface areas was investigated. It was shown that the atmospheric influence depends on activity of UO_2 powder. Combined effects of excess oxygen in nonstoichiometric UO_2 and high surface area of initial powder may limit sintered density and lead to the formation of intergranular type of porosity. In such cases, higher densities may be achieved by sintering at lower temperatures or by sintering in hydrogen. Different observations reported by various investigators on the atmospheric influence on sintering UO_2 may result from different starting materials. Author

N67-35794* Case Inst. of Tech., Cleveland, Ohio. Polymer Science Group.
MORPHOLOGY OF STRAIN-INDUCED CRYSTALLIZATION OF POLYETHYLENE TEREPHTHALATE, PART I Final Report
Gregory S. Y. Yeh and P. H. Geil [1966] 161 p refs
(Grant NGR-36-003-054)
(NASA-CR-88195) CSCL 11I

A study was made with primary emphasis on the morphology of the glass and the effect of strain-induced crystallization of the polymer. Polyethylene terephthalate (PETP) crystallizes from solution in the form of chain-folded fibrillar ribbons as in most solution-grown polymer crystals. The morphology of the glassy state is characterized by 75Å ball-like structures in which the molecules are packed with some order. Crystallization from glassy amorphous PETP occurs by the formation of spherulites consisting of ribbon-like lamellae. The long period increases as measured by small angle X-ray scattering with annealing temperature but it decreases with time at a given annealing temperature. An interpretation is given for this decrease of long period with time. Strain-induced crystallization of PETP occurs by alignment of the ball-like structures. Subsequent heat treatment of the strained material produces more complete alignment of the ball-like structures as well as perfection in the chain packing within the structure. Author

N67-35795# McCrone (Walter C.) Associates, Inc., Chicago, Ill.
TEST PROGRAM ON DURABILITY OF AIRCRAFT COATINGS Final Report
Richard E. Putscher 20 Jun. 1967 35 p
(Contract NOw-66-0391-c)
(AD-654743)

A laboratory investigation was conducted to develop methods for rapidly determining paint coating resistance to oxidation and photochemical degradation. The ultimate objective is development of a rapid test for expected life of paint coatings. Accelerated aging of paint films has been achieved using ultraviolet radiation and oxidizing atmospheres. The resulting gases given off by the films have been analyzed by gas phase chromatography. The chemical nature of the paint film can be identified by this means, and the actual compounds evolved by a series of films have thus been identified. Interestingly enough, most belong to a homologous series of methyl ketones (acetone, methyl ethyl, methyl propyl, methyl butyl and methyl pentyl), although methanol, water, carbon monoxide and carbon dioxide were also found. A study of polyurethane films of known history showed a good relationship between service life for each film and the chemical composition of the gases evolved. Further work is in progress to confirm these promising results and to extend the study to other paint compositions. Author (TAB)

N67-35896* Case Inst. of Tech., Cleveland, Ohio.
MECHANICAL BEHAVIOR OF POLYETHYLENE TEREPHTHALATE AT CRYOGENIC TEMPERATURES, PART II Final Report
C. D. Armeniades, I. Kuriyama, J. M. Roe, and Eric Baer [1966] 28 p refs
(Grant NGR-36-003-054)
(NASA-CR-88270) CSCL 11I

The mechanical behavior of polyethylene terephthalate (PET) was studied at temperatures from 4° to 300°K with a free

oscillating torsion pendulum and an Instron tester. Relaxation studies with noncrystalline specimens show the presence of loss maxima γ,δ and δ at 108°, 45°, and 20°K, in addition to the known β pack at 200°K. Crystalline unoriented samples show an additional peak, ζ, at 8°K. The logarithmic decrement in the β loss region decreases with increasing crystallinity, whereas the low temperature peaks show a more complex behavior. Uniaxial drawing splits the β loss maximum into two peaks and broadens the δ peak. Biaxial drawing accentuates the β loss split and also generates a new peak, δ', at 65°K. The elastic modulus of noncrystalline PET shows steep changes with temperature at 25°, 90°, and 220°K. Biaxially oriented films show a higher modulus, which decreases continuously with temperature. Their toughness at cryogenic temperatures is almost ten times greater than that of the noncrystalline polymer. Author

N67-35961*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
THERMAL INSULATIONS FOR LAUNCH VEHICLE RADIANT HEATING ENVIRONMENTS
Vaughn F. Seitzinger 9 Aug. 1967 32 p refs
(NASA-TM-X-53646) CSCL 11B

A ceramic composite thermal insulation was developed as an alternate material for M-31, the insulation presently used on the aft sections of the booster stages of the Saturn IB and Saturn V launch vehicles. The material, designated as FTA-442A insulation, is comprised of alumina-silica fibers, pigmentary potassium titanate, and asbestos fibers bonded with colloidal silica. The insulating efficiency of the FTA-442A insulation in both radiant and convective heating environments is superior to that of M-31. It is suitable for application to metal substrates, including stainless steel honeycomb sandwich structures, and the mechanical strength and related substrate adhesion are superior to M-31. The material development is described, and selected thermal, optical, and mechanical properties of the insulation are reported and compared to M-31. Author

N67-35992# Air Force Systems Command, Wright-Patterson AFB, Ohio. AF Materials Lab.
PROPOSED METHOD OF DENSITY DETERMINATION FOR SOME INORGANIC FIBERS Final Report, Jun. 1965–Nov. 1966
S. J. Hanchak (Dayton Univ. Res. Inst.), R. G. Spain, and W. Mahieu (Dayton Univ. Res. Inst.) May 1967 19 p refs Prepared jointly with Dayton Univ. Res. Inst.
(AFML-TR-67-65; AD-655077)

A method and preliminary apparatus are proposed for the rapid and accurate determination of inorganic fiber densities. Initial experiments with small glass chips gave a maximum deviation from the density of bulk glass of less than 0.1% with an average deviation of 0.02% for 10 determinations. In essence, the method proposed utilizes immersion of single fibers of short lengths in liquids comprised of a mixture of individual liquids of greater and lesser densities than the fibers. An average of the easily measured liquid densities in which the fiber slowly rises and falls is proposed as the fiber density. Improvements in the technique and apparatus to determine fiber density are presented and further refinements are suggested. Adequately reproducible results were collected for various measurements of glass and quartz fibers. Author (TAB)

N67-36011# Naval Air Engineering Center, Philadelphia, Pa. Aeronautical Materials Lab.
NEW POLYMER RESEARCH AND DEVELOPMENT PROGRAM
C. Nadler, I. H. Custis, and L. Stallings 1 Feb. 1967 42 p refs
(NAEC-AML-2571; AD-654899)

Studies on poly (metal phosphinate) and silicone-carborane (SiB) polymers were directed toward the development of antistatic compositions; high temperature and fluid resistant elastomers and aircraft protective coatings; and multipurpose thickeners for high temperature greases. Potential exists for obtaining materials with -100 to 800F service capability. Water repellent, transparent hydroxyaquochromium methylphonylphosphinate antistatic coatings were produced which approached practical performance requirements. A hydroxyaquochromium methylphenylphosphinate-dioctylphosphinate copolymer thickening agent with E.P. properties successfully formed silicone, diester and polyester greases. New fluorocarbon phosphinic acid intermediates were synsynthesized directed toward improving the metal phosphinate polymer thermal stability and fuel resistance. A new series of flexible to rigid crosslinked chromium phosphinate polymers (m.p. > 500C) were produced which may provide the basis for high temperature aircraft coatings. Limited studies on the silicone-carborane (SiB) elastomer family compounded with antioxidants indicate outstanding thermal stability in the 700 - 900F range. Improvement in physical strength is needed. TAB

N67-36014*# Gillette Research Inst., Inc., Washington, D. C.
COLLOIDAL ASBESTOS FIBRILS AS REINFORCEMENTS FOR POLYMERIC STRUCTURES
Charles A. Rader and Anthony M. Schwartz Washington, NASA, Sep. 1967 29 p
(Contract NASw-1420)
(NASA-CR-893) CFSTI: HC $3.00/MF $0.65 CSCL 11D

The relation of structure strength to the chemical nature of the matrix and the resultant bond strength between asbestos fibers and matrix was examined. Orientation of asbestos fibrils in composites was achieved, and the ultimate strengths of macroscopic asbestos fibers (MF) as well as colloidal ultimate asbestos fibrils (UAF) were determined. Structure strength was found to depend greatly on the chemical nature of the polymeric matrix. Matrix materials well suited to asbestos reinforcement include phenolic resins and polymers containing free carboxyl groups. It was also found that ice is greatly reinforced by asbestos. Little or no strengthening by asbestos was found in the following matrixes: nylon, polypropylene, polyurethanes, and gelatin. Phenolic structures were prepared and reinforced with oriented MF, which had strengths up to about 100,000 psi. The MF tested singly averaged almost 200,000 psi. Thus, the oriented structures which contained 50 volume percent asbestos demonstrated complete utilization of the MF strength. The UAF were shown to be as strong as MF. Partially oriented arrays of UAF were prepared by drawing from colloidal aqueous suspension. The arrays had strengths up to 100,000 psi when impregnated with phenolic, despite the fact that they contained tangled masses of UAF as well as fairly well oriented UAF. Author

N67-36040* Utah Univ., Salt Lake City. College of Engineering.
PARAMAGNETIC RESONANCE EFFECT IN VISCOELASTIC MATERIALS Semiannual Progress Report, Jan. 1–Jun. 30, 1967
K. L. deVries and M. L. Williams 1 Jul. 1967 31 p refs
(Grant NGR-45-003-037)
(NASA-CR-87970; UTEC-DO-049) CSCL 11J

Early results of studies of the fracture mechanisms are described which were obtained with an EPR spectrometer system operating at a microwave frequency from 8.8 to 9.6 GHz and a field modulation frequency of 100 KHz. All tests were made at low microwave power to avoid saturation. A variable temperature accessory was installed that makes it possible to maintain and control the temperature at any value between -185°C and +300°C. Facilities were constructed to control the atmosphere of the sample in the microwave cavity. A hydraulic loading frame, pump, and controls were constructed for tensile loading of the samples in the microwave cavity. Load, strain, and EPR spectra can be simultaneously recorded on a built-in oscillograph system. The experimental setup is described and illustrated. K.W.

N67-36233# General Electric Co., Waterford, N. Y. Silicone Products Div.
INSULATION RESISTANCE OF RTV-11 ENCAPSULED CIRCUITRY AT HIGH HUMIDITY
W. R. Lampe 9 Sep. 1966 10 p
(R66ChSD-116) CFSTI: HC $3.00/MF $0.65

Tests conclude that RTV-11 exhibits high insulation resistance from 77 : 50% R.H. to 100°F and 95% R.H. and that SS-4004 does not adversely affect insulation resistance even while drying. RTV silicone rubber neither detracts from nor enhances the "wet" insulation resistance of encapsulated components. The high water vapor transmission rate of silicone rubber should be recognized by material and design engineers. Performance of electrical components at high humidity conditions should be predicted only on the basis of tests in the environment and not after a post-conditioning period at low humidity. Author

N67-36438 Lockheed Missiles and Space Co., Sunnyvale, Calif.
PECULIARITIES OF THE FRACTURE OF TRANSPARENT POLYMERS BY THE EFFECT OF POWERFUL LIGHT PULSES AT DIFFERENT TEMPERATURES
N. N. Vsevolodov, N. P. Novikov, and Iu. I. Iudin [1967] 10 p refs Transl. into ENGLISH from Prikl. Mekh. i Tekhn. Fiz. (USSR), no. 2, 1967 p 86–89

The effect of powerful light pulses on transparent polymer materials causes fractures internally. In practice, two viewpoints have been advanced to elucidate the cause of the fracture: according to one, the thermal effect of the laser plays the fundamental role in the fracture; according to the other, it is interaction of hypersonic waves. By altering the conditions under which the fracture of the samples occurs it is possible to determine which of the mentioned causes is governing in the fracture of samples of a given material. The peculiarities of fracture under the effect of laser radiation in polymethylmetacrylate, polystyrene, and polycarbonate are investigated. Author

N67-36488# National Inst. for Research in Nuclear Science, Harwell (England). Rutherford High Energy Lab.
FATIGUE TESTS ON PRESSURISED MEMBRANES OF POLYETHYLENE TEREPHTHALATE
A. J. Middleton Feb. 1967 14 p refs
(RHEL/R-140) CFSTI: HC $3.00/MF $0.65

Fatigue of flexible thin windows for high-energy physics apparatus is investigated. The number of load reversals that can be sustained before failure is determined and a practical limit recommended. Author (NSA)

N67-36609 Royal Aircraft Establishment, Farnborough (England).
POLY [TETRAMETHYL-(DINEOPENTYLEN ISOPHTHALATE) DISILOXANE]: A NEW RUBBER HAVING SILOXANE AND CARBOXYLIC ESTER LINKAGES
Sheena M. Somerville and I. M. White Nov. 1966 30 p refs
(RAE-TR-66345)

Poly[tetramethyl-(dineopentylene isophthalate)disiloxane], $HO(SiMe_2 \cdot CH_2 \cdot CMe_2 \cdot CH_2O \cdot OC\text{-}m\text{-}C_6H_4\text{-}CO \cdot OCH_2 CMe_2 \cdot CH_2SiMe_2O)_nH$, was prepared by thermal polycondensation of the corresponding disilanol. The gum so obtained was vulcanised to produce a modified silicone rubber. Properties of the gum, and of filled and unfilled vulcanisates, are reported. The modified polysiloxane was significantly stronger than a general-purpose methyl/vinyl silicone, but did not have such a wide service temperature range. The glass transition temperature was found to be −52°C, whilst weight loss of the unvulcanised gum began at 240–260° in air and at 350° in vacuum. Vulcanisates, whilst showing a useful life at 150° in moist air, have so far shown rapid network scission at 200°. Author

N67-36647# Technische Univ., Berlin (West Germany). Institut fuer Kerntechnik.
METHOD FOR THE CALCULATION OF PHASE DIAGRAMS OF BINARY OXIDE SYSTEMS [METHODEN ZUR BERECHNUNG VON SCHMELZDIAGRAMMEN BINAERER OXID-SYSTEME]
Wolfgang Reichelt and Boda Gross Nov. 1966 94 p refs In GERMAN
(TUBIK-2)

Previously known possibilities for calculation of fusion diagrams of binary oxide systems from general thermodynamic data are indicated and various methods were used for the calculation of such diagrams. High-melting oxides and two substances, UO_2 and BeO, important in nuclear technical problems were considered. The agreement obtained between the measured and calculated phase diagrams depends on the accuracy of the thermodynamic data underlying the calculations and on the experimentally determined diagrams. Author (NSA)

19 MATHEMATICS

Includes calculation methods and theory; and numerical analysis. For applications see: 08 Computers.

N67-35313# Johns Hopkins Univ., Baltimore, Md. Dept. of Statistics.
TESTING FOR UNIFORMITY ON A COMPACT HOMOGENEOUS SPACE
R. J. Beran Jun. 1967 28 p refs
(Contract Nonr-4010(09))
(TR-75; AD-654464)

This paper applies the invariance principle to the problem of testing a distribution on a compact homogeneous space for uniformity. The notion of using a reduction by invariance in such a situation is due to Ajne, who considers tests invariant under rotation on a circle. In his paper, he derives the distribution of the maximal invariant and gives the general form of the most powerful invariant test for uniformity on the circle. He proposes two simple test criteria. The present paper deals with an extension of some of these ideas to a compact homogeneous space. TAB

N67-35343# Washington Univ., Seattle. Statistical Research Lab.
THE PROBABILITY THAT THE SAMPLE DISTRIBUTION FUNCTION LIES BETWEEN TWO PARALLEL STRAIGHT LINES
J. Durbin 30 Apr. 1967 30 p refs
(Contract Nonr-477(38))
(TR-48; AD-654484)

Suppose that $0 < X1 < \ldots < Xn < 1$ is an ordered sample from the uniform distribution on (0,1), and Fn(x) the corresponding empirical distribution function. Let S be the sample path of Fn(x) as x moves from 0 to 1. In this paper we consider the probability pn(a,b,c) that S lies entirely in the region between the lines $ny = a + (n+c)x$ and $ny = -b + (n+c)x$, $a > 0$, $b > 0$. Author (TAB)

N67-35357# Michigan State Univ., East Lansing. Dept. of Statistics and Probability.
REPRESENTATION OF NON-NEGATIVE CONTINUOUS FUNCTIONS ON PRODUCT SPACES
Herman Rubin 12 Jun. 1967 6 p
(Contract Nonr-2587(02))
(RM-187; HR-18; TR-15; AD-654476)

The purpose of this note is to show that a non-negative continuous function on a locally compact sigma-compact product space is a countable sum of products of factor functions. That is, if f is a non-negative continuous function on Chi(subscript alpha, epsilon, A)X(subscript alpha), there exist non-negative continuous functions g(subscript alpha i), such that for each i only finitely many g(subscript alpha i) are not identically 1, and for all x, f(x) = Summation over i of (Phi(subscript alpha) g(subscript alpha i)x(subscript alpha)). TAB

N67-35412# Michigan State Univ., East Lansing. Dept. of Statistics and Probability.
SOME RESULTS ON CONVERGENCE RATES AND ASYMPTOTIC BEHAVIOUR FOR THE LAWS OF LARGE NUMBERS
Vijay Kumar Rohatgi Jun. 1967 99 p refs
(Contract Nonr-2587(05))
(RM-188; VKR-5; AD-654477)

Contents: Convergence rates in the law of large numbers for sums of independent and identically distributed random variables; Convergence rates in the law of large numbers for independent random variables; Convergence rates in the law of large numbers for weighted sums of independent random variables; A large deviation problem. TAB

N67-35542# RAND Corp., Santa Monica, Calif.
(G,W)—OPTIMA IN MARKOV RENEWAL PROGRAMS
Bennett Fox Jul. 1967 9 p refs Submitted for publication
(P-3624; AD-655064)

Policies nearly optimal for small discount rates (more precisely, (g,w) - optimal policies) are found for completely ergodic Markov Renewal Programs by linear programming. Author (TAB)

N67-35587# System Development Corp., Santa Monica, Calif.
ON REAL ELEMENTARY FUNCTIONS
Robert H. Risch 22 May 1967 11 p refs
(SP-28001/001/00; AD-654594)

The report supplements the work of The Problem of Integration in Finite Terms, (AD-651 587) by modifying the results there so that they apply to elementary functions built up with real operations as sin, 1/tan, cosh, etc. It is shown that if a function is given to us in a real form, its elementary integral, if it exists, must also be expressible in a real form, i.e., without the use of complex numbers. Also, shown is the use of the algorithm of section 3 of the aforementioned paper to integrate real elementary functions. Author (TAB)

N67-35614*# National Aeronautics and Space Administration. Electronics Research Center, Cambridge, Mass.
ROUNDING ERROR BOUNDS BY PERTURBATION-CONDITION ANALYSIS
Donald J. Rose Washington, NASA, Sep. 1967 33 p refs
(NASA-TN-D-4113) CFSTI: HC$3.00/MF$0.65 CSCL 12A

The problem of finding bounds to the error generated by roundoff is discussed, and definitions are given for the terms forward analysis, backward analysis, inherent error, and propagated error. t he condition, meaning, and advantages of perturbation-condition analysis are examined, and several examples are given to show the use of this technique. The conjecture that norm reduction can be used to condition matrice for the eigenvalue problem is considered. Numerical examples are included to show the use of an algorithm which reduces the Euclidean norm, and an eigenvalue routine. M.G.J.

N67-35628# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.
ON SECOND-ORDER LINEAR EQUATIONS OF NON-NEGATIVE CHARACTERISTIC SHAPE
O. A. Oleinik 1 May 1967 46 p refs Transl. into ENGLISH from Mat. Sb. (Moscow), v. 69(111), no. 1, 1966 p 111–140
(Contract NOw-62-0604-c)
(TG-230-T521; TT-67-62238; AD-654561)

This paper gives a complete existence-uniqueness-regularity theory of the first boundary value problem for the equation L(u) = A(superscript ij)(x) u(subscript ij) + b(superscript i)(x) u(subscript i) + c(x)u = f(x) (subscripts of u denote differentiation), where a(superscript ij)(x) xi(subscript i) xi(subscript j) = or > 0 for all x in the given domain, and all vectors xi. TAB

N67-35630# Bell Aerosystems Co., Buffalo, N. Y.
STUDY OF NUMERICAL INTEGRATION TECHNIQUES FOR REAL-TIME DIGITAL FLIGHT SIMULATION Final Report, Feb. 1966–Jan. 1967
Bart J. Nigro Wright-Patterson AFB, Ohio, AMRL, Mar. 1967 245 p refs
(Contract AF 33(615)-3523)
(AMRL-TR-67-4; AD-654307)

A comprehensive and rigorous mathematical analysis of numerical integration techniques for real-time digital flight simulation is presented. Accuracy and efficiency of methods as well as stability of numerical solutions are examined in detail. These investigations allow the subject of best integration methods and their derivation to be pursued. Best methods based on accuracy/efficiency and on stability are developed; in addition, the Stability Chart and Z-Transform approaches are examined. This study allows certain evaluational techniques to be derived. Notable among these are a technique for evaluating any integration method and a technique for deriving a best method for a given digital flight simulation problem. A demonstration section is included wherein the utility of these techniques is established. Author (TAB)

N67-35647# White Sands Missile Range, N. Mex. Atmospheric Sciences Lab.
ON NONPARAMETRIC TESTING OF THE NATURE OF CERTAIN TIME SERIES
Walter B. Miller and Henry Rachele Apr. 1967 36 p refs
(ECOM-5122; AD-654992)

Nonparametric tests were adapted and used to determine if a given set of samples from a time series is stationary, tau-dependent and Markov. Results obtained from analyzing (testing) a number sequence generated by a random number generator and sets of wind speed and direction data collected at White Sands Missile Range are presented. Author (TAB)

N67-35682# New York Univ., N. Y.
FINITE VERSIONS OF THE AXIOM OF CHOICE
Martin Michael Zuckerman (Ph.D. Thesis—Yeshiva Univ.) Jun. 1967 117 p refs
(Grant AF-AFOSR-995-67)
(ALG-1; AFOSR-67-1520; AD-655088)

We consider A. Mostowskis axioms of choice for finite sets, (n), which state that for every set X whose elements are n-element sets, there is a function fX such that fX (x) epsilon X for each x epsilon X. We extend some of Mostowskis results concerning necessary (respectively, sufficient) conditions for implications of the form ((m1) and (m2) and ... and (mk)) approaches (n), and we introduce some new necessary (respectively, sufficient) conditions for this implication. Some of these results are in terms of an associated number-theoretic function mu(n), defined for integers n = or > 2 as the greatest prime p such that n is expressible as the sum of primes not less than p. Properties of mu(n) in relation to the axioms of choice for finite sets are obtained by consideration

of modified versions of Bertrands Postulate. Some of the independence theorems are obtained by constructing Fraenkel-Mostowski-type models for set theory. Author (TAB)

N67-35698# University of Southern Calif., Los Angeles. Dept. of Electrical Engineering.
SOLUTION OF INTEGRAL EQUATIONS BY HYBRID COMPUTATION
George A. Bekey, Rajko Tomovic, and James C. Maloney Apr. 1967 25 p refs
(Grant AF-AFOSR-1018-67)
(USCEE-178; AFOSR-67-1485; AD-654633)

Two alternative approaches to the hybrid computer solution of a class of integral equations are presented in this report. The first approach is based on a direct hybrid mechanization of the classical Neumann iterative procedure. The second iterative method, due to Fisher, leads to considerably faster convergence than the classical technique. The methods are compared from the standpoints of accuracy and computer implementation. Illustrative examples include several Fredholm-type integral equations. Extension of the technique to other types of integral equations is discussed in the concluding section of the report. Author (TAB)

N67-35699# Air Force Cambridge Research Labs., Bedford, Mass. Solid State Sciences Lab.
THREE FAMILIES OF INTEGRALS WHICH ARISE IN SOME THREE-BODY PROBLEMS Interim Scientific Report
John R. Jasperse Apr. 1967 32 p refs Presented at Slater Symp., Sanibel Island, Fla., Jan. 1967 and at the Am. Phys. Soc. Meeting, Washington, D. C., Apr. 1967 *Its* Phys. Sci. Res. Papers, No. 321
(AFCRL-67-0222; AD-654299)

Three families of integrals that arise in the three-body problem with Coulomb pair potentials are examined. Two of the families are definite integrals on a single variable where the integrands are products of two Coulomb Sturmian functions. The third family is a triple integral where the integrands are products of four Coulomb Sturmian functions and two Legendre polynomials. Closed-form expressions are derived for all the integrals, except for one subset of the most general triple integral. An outline of the procedure necessary to obtain a closed expression for this subset is given. Author (TAB)

N67-35703# Texas Univ., Austin. Computation Center.
NUMERICAL STUDIES ON THE CONVERGENCE OF THE PEACEMAN–RACHFORD ALTERNATING DIRECTION IMPLICIT METHOD Interim Technical Report
Alkis J. Mouradoglou (M.A. Thesis) Jun. 1967 60 p refs
(Grants DA-ARO(D)-31-124-G721; NSF GP-5253)
(AROD-3772-32-M; ITR-14; AD-654526) CFSTI: HC $3.00/MF $0.65

The Peaceman-Rachford alternating direction implicit iterative method has proved to be a very effective method for solving difference equations arising in the solution of elliptic partial differential equations by finite difference methods, but no general proofs exist concerning the convergence for nonrectangular regions with several iteration parameters even for difference equations corresponding to Laplace's equation. The purpose of this paper is to describe some theoretical studies on the convergence properties of the Peaceman-Rachford method for solving the discrete analogue of the Dirichlet problem for nonrectangular regions. To facilitate these studies a computer program has been prepared for the Control Data 6600 computer. TAB

N67-35712# Hawaii Univ., Honolulu. Dept. of Electrical Engineering.
EUCLIDEAN GEOMETRY CYCLIC CODES
E. J. Weldon, Jr. 15 Feb. 1967 22 p refs
(Contract AF 19(628)-4379)
(AFCRL-67-0178; SR-13; AD-654675)

A class of Random-error-correcting cyclic codes is defined and investigated. It is shown that a suitable choice of generator polynomial guarantees that the polynomials corresponding to all subspaces of a given dimensionality in a particular Euclidean geometry are in the null space of the code. These subspaces (flats) are useful in deriving a seemingly tight lower bound on the minimum distance of the codes. This bound shows that for practical values of code length the codes are rather efficient random-error-correctors, although not quite as efficient as the Bose-Chaudhuri-Hocquenghem codes. The class of Euclidean geometry codes, as they have been called, contains the class of Reed-Muller codes. It is shown that with a slight modification the decoding algorithm for these latter codes can be applied to the Euclidean geometry codes. This algorithm, referred to in the literature both as the Reed Algorithm and majority-logic decoding, can be implemented in a surprisingly simple manner. Author (TAB)

N67-35738*# Pittsburgh Univ., Pa.
APPLICATION OF LYAPUNOV STABILITY THEORY TO SOME NONLINEAR PROBLEMS IN HYDRODYNAMICS
Gabe R. Buis and William G. Vogt Washington, NASA, Sep. 1967 23 p refs
(Grant NsG-39-011-039)
(NASA-CR-894) CFSTI: HC $3.00/MF $0.65 CSCL 20D

Lyapunov stability theory is used to analyze the stability properties of equilibrium solutions to some linear and nonlinear partial differential equations. Stability conditions are established for systems which have, as a linear part, a self-adjoint differential operator or one which can be transformed into a self-adjoint differential operator. Although the techniques described are applied to systems occurring in hydrodynamics the methods can be used for similar problems in other fields as well. Author

N67-35750# RAND Corp., Santa Monica, Calif.
JOSS: PROBLEM SOLVING FOR ENGINEERS
E. P. Gimble May 1967 88 p
(Contract F44620-67-C-0045; Proj. RAND)
(RM-5322-PR; AD-654287)

The report includes a step-by-step demonstration of the basic principles of JOSS operation to enable engineers to solve progressively more involved problems in numeric calculation. Following an overview of the JOSS system, including descriptions of the console and language, examples of JOSS input and output demonstrate how the basic commands, both direct and indirect, are applied. The appendices include a list of legitimate JOSS commands, a description of the use of expressions and propositions, and a discussion of the available JOSS functions. TAB

N67-35799# Johns Hopkins Univ., Baltimore, Md. Dept. of Statistics.
ON ROBUST LINEAR ESTIMATORS
Joseph L. Gastwirth and Herman Rubin (Michigan State Univ.) May 1967 33 p refs Prepared jointly with Michigan State Univ.
(Contract Nonr-2587(02); Grant NSF GP-6225)
(TR-74; AD-654463)

The problem of finding robust estimators for the location parameter of symmetric unimodal distributions has been the subject of much recent research. This paper is concerned with finding robust estimators which are linear functions of the ordered observations. TAB

N67-35804# Joint Publications Research Service, Washington, D. C.
COMPARATIVE ANALYSIS OF TWO PROCEDURES FOR CALCULATING THE OPTIMAL DISTRIBUTION OF LIMITED RESOURCES
I. N. Kuznetsov and A. D. Lobanova *In its* Tech. Cybernetics, No. 3, 1967 21 Aug. 1967 p 22–29 refs (See N67-35801 21-10)

A method is discussed for finding the optimal distribution of limited resources in a one-dimensional case using a computer. The investigated method is based on using the properties of optimal distribution. A comparison of this method with the method of dynamic programming is made. Author

N67-35806# Joint Publications Research Service, Washington, D. C.
METHOD OF SOLUTION OF A PROBLEM OF INTEGRAL CONVEX PROGRAMMING
S. S. Lebedev *In its* Tech. Cybernetics, No. 3, 1967 21 Aug. 1967 p 37–51 refs (See N67-35801 21-10)

Consideration is given to the special problem of convex integral programming having applications in reliability theory and queueing theory. The problem reduces to a linear problem without requirements of being integral. For the latter, two finite algorithms are developed in which the resolving factors are not used. Author

N67-35807# Joint Publications Research Service, Washington, D. C.
STOCHASTIC ε-STABILITY OF THE SOLUTION OF A PROBLEM OF QUADRATIC PROGRAMMING
N. I. Arbuzova *In its* Tech. Cybernetics, No. 3, 1967 21 Aug. 1967 p 52–61 refs (See N67-35801 21-10)

In the space of the random parameters of the problem of convex programming the stability region is isolated for purposes of estimating its size. For illustration of the concepts introduced, the space of the parameters of the two-dimensional problem of linear programming is subdivided into regions of attraction of various bases. Author

N67-35811# Joint Publications Research Service, Washington, D. C.
SOME PROBLEMS OF DISTANCE ON A GRAPH
S. V. Trufanov *In its* Tech. Cybernetics, No. 3, 1967 21 Aug. 1967 p 92–101 refs (See N67-35801 21-10)

Two problems of distance on a graph are investigated. Recurrent expressions are obtained for the rate of propagation of the disturbance on a specially constructed infinite graph, and the upper limit of the distance in a finite equicentral graph. Author

N67-35812# Joint Publications Research Service, Washington, D. C.
CALCULATION OF THE LOWER FIDUCIAL BOUND FOR THE PROBABILITY OF FAILFREE OPERATION OF COMPLEX SYSTEMS, II
Yu. K. Belyayev, T. N. Dugina, and Ye. V. Chepurin *In its* Tech. Cybernetics, No. 3, 1967 21 Aug. 1967 p 102–118 refs (See N67-35801 21-10)

The general methods of construction of fiducial sets and theorems are presented. Based on these data, the search algorithm for the minimum nonlinear function in a truncated rectangle is constructed. Author

N67-35816# Joint Publications Research Service, Washington, D. C.
EVALUATION OF ATTRIBUTES OBTAINED IN STATISTICAL DECISION RULES
A. L. Lunts and V. L. Brailovskiy *In its* Tech. Cybernetics, No. 3, 1967 21 Aug. 1967 p 149–165 refs (See N67-35801 21-10)

Two problems related to evaluating the attributes obtained in statistical decision rules are discussed: (1) evaluation of the attributes obtained as a result of the initial sorting; and (2) evaluation of the results of training with the help of the same sample on which the training took place. The results obtained from the second problem contain an evaluation of the quality of approximation of the function with respect to the sample. Author

N67-35844# Brookhaven National Lab., Upton, N. Y. Accelerator Dept.
STEP-FUNCTION APPROXIMATIONS TO COS nθ
Richard A. Beth 11 Apr. 1967 11 p refs
(BNL-11337; AADD-135) CFSTI: HC $3.00/MF $0.65

It is shown how the step-function to imitate cos n θ should be specified to get the best harmonic approximation with N steps. NSA

N67-35876# General Electric Co., Schenectady, N. Y. Research and Development Center.
OPTIMUM TESTS WITH GROUPED DATA FROM AN EXPONENTIAL DISTRIBUTION
W. G. Nelson Oct. 1966 19 p refs
(Rept.-66-C-398)

Statistical methods (particularly useful in reliability measurement and demonstration) of treating grouped data on items having exponentially distributed times to failure are given. The maximum likelihood method of estimation for mean life is presented with tables for optimum test planning. A statistical (demonstration) test for mean life that is locally most powerful and is simpler than the test based on the maximum likelihood estimate is described. Tables for this test are provided. These methods are extended to apply to items with times to failure with a Weibull distribution with known shape parameter. Author

N67-35890# Harvard Univ., Cambridge, Mass. Dept. of Statistics.
DISTRIBUTIONS DETERMINED BY CUTTING A SIMPLEX WITH HYPERPLANES
A. P. Dempster and Robert Kleyle 15 May 1967 12 p refs
(Contract Nonr-1866(37))
(TR-17; AD-655118)

A geometric derivation is given for the probability that a uniformly distributed random point in a simplex shall be on one side of a given hyperplane. The argument extends directly to several hyperplanes. Author (TAB)

N67-35918# Florida State Univ., Tallahassee. Dept. of Statistics.
THE TREATMENT OF TIES IN PAIRED COMPARISONS
Jagbir Singh and W. A. Thompson, Jr. Jun. 1967 48 p refs
(Contract Nonr-988(08))
(FSU-M122; ONR-TR-23; AD-654896)

Section 2 generalizes some concepts in directed graphs to configurations, called bigraph, which have directed as well as undirected lines. Several relations are defined in terms of a bigraph. Conditions are found under which it is possible to find weak, partial, and simple orders as well as preference relations. An application of this theory is found in following sections 3 and 4. These sections deal with the estimation of an order relation from paired comparisons in which ties may occur. Author (TAB)

N67-35920# Florida State Univ., Tallahassee. Dept. of Statistics.
THE INFORMATION IN A RANK-ORDER AND TERMINATION OF SOME ASSOCIATED SPRTS
Robert H. Berk and I. Richard Savage Jun. 1967 23 p refs
(Contract Nonr-988(13))
(FSU-M123; AD-654897)

For a large class of situations the two sample sequential probability ratio test are shown to terminate with probability one. The results are obtained by showing the convergence of the logarithm of the n-th root of the probability ratio to a difference of two Kullback-Leibler information numbers. These results partially solve the general problem of Savage and Sethuraman (Ann. Math. Statist. 37 (1966) 1154-1160). Author (TAB)

N67-35945# Technische Hogeschool, Eindhoven (Netherlands).
INTEGRATION IN LOCALLY COMPACT SPACES BY MEANS OF UNIFORMLY DISTRIBUTED SEQUENCES
Karel Albertus Post (Ph.D. Thesis) 20 Jun. 1967 84 p refs
CFSTI: HC $3.00/MF $0.65

The behavior of unbounded functions is examined with respect to a uniformly distributed sequence. Lemmas are derived concerning dμ-uniformly distributed sequences and set-theoretical topology. It is shown that there are limitations to the possibility of extending the range of functions, for which (ξ,dμ)-summability can be established, even when continuous functions only are established. The (ξ,dμ)-summability for a larger class of Borel-measurable functions is then investigated. The topological and measure-theoretical background for some theorems are given and proved, and examples to illustrate the results are included. M.G.J.

N67-35950# Technische Hochschule München (West Germany). Fakultaet fuer Allgemeine Wissenschaften.
TOWARD A GRASP OF PROCEDURE IN ALGORITHMIC LANGUAGES [ZUM BEGRIFF DER PROZEDUR IN ALGORITHMISCHEN SPRACHEN]
Gerhard Seegmueller (Ph.D. Thesis) 1966 100 p refs In GERMAN
CFSTI: HC $3.00/MF $0.65

Discussed are the procedural concepts and parameters of the Algol 60 model computer language and its expansion to related algorithmic languages. Sequential programming to evaluate primary terms and side effects of functions, the static and dynamic concepts of repeat instruct and distributor stipulation, the "own" concept, procedural parameters, and finally the recursive recall procedures are briefly presented for basic Fortran, Algol 58, algol 60, and PL/I. Transl. by G.G.

N67-36057# California Univ., Berkeley. Lawrence Radiation Lab.
INVARIANT SURFACES OF ORDINARY DIFFERENTIAL EQUATIONS WITH AND WITHOUT TIME LAG
Anthony J. Schaeffer (Ph.D. Thesis) Apr. 1967 76 p refs
(Contract W-7405-ENG-48)
(UCRL-17525) CFSTI: HC $3.00/MF $0.65

Consider the system of differential equations (1) $\dot{\theta}(t)=\Theta[\theta(t-r), x(t-r), \epsilon]$ and (2) $\dot{x}(t) = A[\theta(t-r), \epsilon]\, x(t-r) + X[\theta(t-r), x(t-r), \epsilon]$, where $r = 0$ when there is no time lag. A mapping $S:R^m \to R^n$ is an invariant surface of (1,2) if the pair $\langle \psi(t), S[\psi(t)] \rangle$ is a solution of (1,2) where $\psi(t)$ is a solution of the equation (3) $\dot{\theta}(t)=\Theta\langle\theta(t-r), S[\theta(t-r)], \epsilon\rangle$, which must be defined for all time if $r>0$. For $\epsilon=0$, it is assumed that $S_0(\theta)=0$ is an invariant surface of (1,2) and it is shown that under suitable conditions on Θ, A, and X there exists a unique invariant surface of (1,2) near S_0 for ϵ small. The essential conditions on Θ, A, and X are that: all be differentiable with respect to x and θ; no characteristic roots of A ever be purely imaginary, and A not depend on θ if there is time lag; and X have a small linear term, plus higher order terms, in x. More general time lag terms are allowed and a systematic treatment of differential equations with time lag is given. Author (NSA)

N67-36113# Texas Univ., Austin. Computation Center.
THE QR ALGORITHM APPLIED TO HESSENBERG MATRICES
Lou Ann Naiser (M.S. Thesis) Jun. 1967 116 p refs
(Grant DA-ARO(D)-31-124-G721; NSF GP-5253)
(ITR-12; AROD-3772-30-M; AD-654425)

The report presents a detailed discussion of the QR algorithm for finding all the eigenvalues of an arbitrary real or complex matrix. It contains a complete mathematical analysis, including several convergence proofs, and also a detailed description of the algorithm as it would be used on a high-speed computer to find the eigenvalues of a real matrix. Author (TAB)

N67-36119# Douglas Aircraft Co., Inc., Santa Monica, Calif. Missile and Space Systems Div.
MARKOV PROCESSES AND SOME AEROSPACE APPLICATIONS
G. J. Schick 22 Jun. 1967 35 p refs Presented at 48th Ann. Meeting Pacific Div. Am. Assoc. for the Advan. of Sci., Los Angeles, 22 Jun. 1967
(Douglas Paper-4588)

The basic properties of Markov processes are defined, and their application to decision making is shown. Models, which are probabilistic in form, are derived for the discrete and continuous Markov processes, an R-dimensional process, the Wiener process, and the Poisson process. Examples are provided to show their use in reliability equations, optimal replacement policies, physics, availability models, and industrial applications. M.G.J.

N67-36148# Akademiya Nauk URSR, Kiev. Institut Teoreticheskoi Fiziki.
ON DECOMPOSITION OF DIRECT PRODUCTS OF IRRIDUCIBLE REPRESENTATION OF SEMISIMPLE LIE ALGEBRAS INTO IRREDUCIBLE REPRESENTATIONS [O RAZLOZHENII PRYAMOGO PRIOZVEDENIYA NEPRIVODIMYKH PREDSTAVLENII POLUPROSTYKH ALGEBR LI NA NEPRIVODIMYE PREDSTRALENIYA]
A. U. Klimyk 1966 16 p refs In RUSSIAN, ENGLISH summary
(NP-16679)

A direct product of irreducible representations of complex semisimple Lie algebras is considered. A condition for the highest weights of component representations which leads to a simple form for decomposition of a direct product of representations into irreducible representations id derived. Also, the classical algebras A_1, B_1, C_1, D_1 are considered. Author (NSA)

N67-36162# RAND Corp., Santa Monica, Calif.
DIFFERENTIAL SYSTEMS FOR EIGENVALUES OF FREDHOLM INTEGRAL EQUATIONS
Harriet Kagiwada, Robert Kalaba, and Alan Schumitzky (Univ. of Southern Calif., Los Angeles) Jun. 1967 21 p refs
(Contract F44620-67-C-0045; Proj. RAND)
(RM-5361-PR; AD-654281)

The practical computational solution of nonhomogeneous Fredholm integral equations is extended to the eigenvalue problem for homogeneous integral equations. The eigenvalues and eigenfunctions are viewed at a fixed point as functions of the interval length. A complete set of ordinary differential equations is derived for these and other related quantities. Analogous systems of equations are developed for displacement kernels and Greens functions. Certain problems concerning the initial conditions remain. Two methods to circumvent this obstacle are discussed. Author (TAB)

N67-36428# Aerospace Medical Div. Aerospace Medical Research Labs. (6570th), Wright-Patterson AFB, Ohio.
THE APPLICATION OF SCHUR'S ALGORITHM TO THE DERIVATION OF OPTIMAL NUMERICAL INTEGRATION TECHNIQUES FOR DIGITAL FLIGHT SIMULATION
Technical Report, Jun.–Sep. 1966
Patricia A. Knoop Mar. 1967 48 p refs
(Contract AF 33(615)-3523)
(AMRL-TR-67-3; AD-654320)

The report describes the derivation and application of a computer-oriented technique for synthesizing numerical integration methods which are optimal on the basis of stability alone. The local growth of propagated error during a numerical integration and its affect on stability is explored. Also, a unique approach for deriving both classical and non-classical integration methods is presented. Schurs algorithm is used to formulate the search for an optimal kth-order integration method as a non-linear programming problem suitable for computer implementation. First and second order methods which are optimal on the basis of stability alone are

derived. Finally, the technique developed in this study is used to derive the stability ranges for several well known integration formulae for purposes of evaluating their adequacy for a given simulation problem. Author (TAB)

N67-36498 Lockheed Missiles and Space Co., Sunnyvale, Calif.
ON THE ANALYSIS OF THE EXCURSIONS OF RANDOM FUNCTIONS
A. S. Gusev [1967] 5 p refs Transl. into ENGLISH from Izv. Vyssh. Ucheb. Zaved., Mashinostro. (Moscow), no. 3, 1967 p 27-31

The problem of determining the number of excursions of a random function beyond a certain level possessing statistical properties is considered herein. This problem is of interest in connection with the question of cumulative damage and the estimation of the reliability of a structure under random loadings. The case investigated herein is when the "danger" level can be represented as a series with stochastic coefficients distributed normally, and according to Rayleigh. Author

N67-36539# Illinois Univ., Urbana. Dept. of Computer Science.
NUMERICAL INTEGRATION OF STIFF ORDINARY DIFFERENTIAL EQUATIONS
C. W. Gear 20 Jan. 1967 24 p refs Sponsored in part by Argonne Natl. Lab., Ill.
(Contract AT(11-1)-1469)
(COO-1469-0051; Rept.-221) CFSTI: HC $3.00/MF $0.65

Stiff equations are ones in which there are rapidly decaying components which are of no interest because of their small magnitude. Equations of this form frequently arise in physical equilibrium problems such as chemical or nuclear reactions where there are many components with a large range of time constants. Although the rapidly decaying components are of small magnitude, they cause severe numerical problems in most general purpose integration methods. The cause of these problems is examined and some ways around them are proposed. Some specific methods are developed, but the investigation of classes of methods remains to be done. Author (NSA)

N67-36608# Michigan Univ., Ann Arbor. Systems Engineering Lab.
A PARAMETRIC STUDY OF MATCHINGS AND COVERINGS IN WEIGHTED GRAPHS
Lee J. White May 1967 181 p refs
(Contract AF 30(602)-3546)
(Rept.-06920-11-T; SEL-TR-13; AD-654738)

Given a weighted graph, a matching is a subset of the edges such that no two edges of the subset are incident to the same vertex. A covering is a subset of the edges such that each vertex is incident to at least one edge of the subset. Two problems are to find a maximum weight matching and minimum weight covering. Edmonds has developed an algorithm of algebraic growth to find a maximum matching. A review of this method is presented. A new algorithm for the solution of the minimum covering problem is developed. Under certain conditions, Lagrange multiplier methods can be applied to discrete programming problems. This is called the parametric approach, and is used here to find maximum matchings, subject to the condition that the number of edges in the solution is some fixed number, k. A study of methods for this k-cardinality problem indicates several improvements in Edmonds matching algorithm. The parametric technique is extended to solve the minimum k-cardinality covering problem. This algorithm is shown to be a generalization of Kruskals algorithm for a minimum spanning tree. This leads to a discussion of matroid systems and greedy algorithms, and their relationship to the parametric approach. Matchings and coverings in weighted graphs have applications in resource allocation, diagnostics, and large scale system design. TAB

N67-36645# Joint Inst. for Nuclear Research, Dubna (USSR).
DISCRIMINATION OF STATISTICAL HYPOTHESES OF THE VALUES OF X^2 OF THE SAME ORDER [DISKRIMINATSIYA STATISTICHESKIKH GIPOTEZ PRI BLIZKIKH ZNACHENIYAKH X^2]
Yu. M. Kazarinov, V. S. Kiselev, A. M. Rozanova, and I. N. Silin 1967 19 p refs In RUSSIAN; ENGLISH summary
(JINR-P1-3268)

A method was suggested for evaluating the probability of a first type error if one rejects the hypothesis of a larger value of χ^2 with the χ^2 difference of two hypotheses $\Delta\chi^2 \geq 10$ with a larger number of freedom degrees when the proabilities of hypotheses on the χ^2-criterion are of the same order. The problem is solved in two stages. First, in formulating the problem according to Neumann–Pirson the probability of the first type error is estimated for the case of fixed hypotheses (without the fitted parameters). Further, this result is used to obtain the majorized estimate of the probability of the first type error in the case of linear dependence of the hypotheses on the fitted parameters for which the ignorance of the exact hypothesis turns out to be unessential. The result can be used in the case of quasi-linear hypotheses as well. The evaluation of P was used to discriminate between solutions in the phase-shift analysis of nucleon–nucleon scattering at 630 MeV. In this case two of the three solutions obtained earlier were rejected with $P \leq 0.1\%$ probability. The difference χ^2 of these solutions with χ^2 for the best of the solutions turned out to be 13.66 and 19.10 for the number of freedom degrees as large as 207. Author (NSA)

20 METEOROLOGY

Includes climatology; weather forecasting; and visibility studies. For related information see also: 13 Geophysics; and 30 Space Sciences.

N67-35315* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
EARTH ALBEDO MEASUREMENTS, JULY 1, 1963–JUNE 30, 1964
Albert Arking and Joel S. Levine (New York Univ.) [1967] 14 p refs
(NASA-TM-X-60233) CSCL 04B

The geographic distribution of incoming solar radiation has been determined from an analysis of the TIROS VII visible channel data for the period July 1, 1963, to June 30, 1964. This study differs from previously reported work in that the dependence of the measured intensity on the solar zenith angle, the satellite zenith angle, and the relative azimuth angle between sun and satellite is taken into account in reducing the measurements. The results show a latitudinal distribution of albedo which duplicates the characteristic features of cloud cover patterns; there is a local peak near the equator which follows the solar declination with a time lag of about a month. The monthly values of the quasi-global albedo show an appreciable drop during the months of May through August with an especially low value during May. Author

N67-35331 Joint Publications Research Service, Washington, D. C.
NEW METHODS IN METEOROLOGICAL MEASUREMENTS
26 May 1967 45 p refs Transl. into ENGLISH from Tr. Gl. Geofiz. Observ. (Leningrad), No. 199, 1966
(JPRS-41176; TT-67-31817) CFSTI: $3.00

CONTENTS:

1. AIR HUMIDITY MEASUREMENT BY THE OPTICAL-ACOUSTIC METHOD V. I. Mikhaylenko p 1–15 refs (See N67-35332 21-20)

2. A METHOD FOR DETERMINING THE CHARACTERISTICS OF THE PRESSURE TENDENCY AT AUTOMATIC HYDROMETEOROLOGICAL STATIONS Ye. N. Shadrina p 16–25 (See N67-35333 21-20)

3. DETERMINATION OF EXTREMAL AIR TEMPERATURE VALUES USING AUTOMATIC HYDROMETEOROLOGICAL STATIONS Ye. N. Shadrina p 26–33 (See N67-35334 21-20)

4. IMPROVING THE METHOD FOR CHECKING ACTINOMETRIC INSTRUMENTS IN THE LABORATORY V. A. Klevantsova p 34–38 refs (See N67-35335 21-14)

N67-35332 Joint Publications Research Service, Washington, D. C.

AIR HUMIDITY MEASUREMENT BY THE OPTICAL-ACOUSTIC METHOD

V. I. Mikhaylenko *In its* New Methods in Meteorol. Meas. 26 May 1967 p 1–15 refs (See N67-35331 21-20)

The optical–acoustical method for the analysis of gases is discussed from the point of view of its application for hygrometric purposes. A description is given of the operation and design of an optical–acoustic hygrometer useful in making meteorological measurements, control measurements in hygrostats and regulation of humidity in hygrostats, and other apparatus requiring control and regulation of air humidity. Author

N67-35333 Joint Publications Research Service, Washington, D. C.

A METHOD FOR DETERMINING THE CHARACTERISTICS OF THE PRESSURE TENDENCY AT AUTOMATIC HYDROMETEOROLOGICAL STATIONS

Ye. N. Shadrina *In its* New Methods in Meteorol. Meas. 26 May 1967 p 16–25 (See N67-35331 21-20)

A method for determining the characteristics of the pressure tendency on the basis of discrete pressure measurements is proposed and analyzed. This method is intended for use in the automation of measurements and can be employed in the presently operating network. Author

N67-35334 Joint Publications Research Service, Washington, D. C.

DETERMINATION OF EXTREMAL AIR TEMPERATURE VALUES USING AUTOMATIC HYDROMETEOROLOGICAL STATIONS

Ye. N. Shadrina *In its* New Methods in Meteorl. Meas. 26 May 1967 p 26–33 (See N67-35331 21-20)

A method is proposed for obtaining the extreme temperature values using air temperature measurements at discrete times. An approximation method involving polynomials is used to restore the curve. The accuracy of the method was checked and considered satisfactory. N.E.N.

N67-35414# Frankford Arsenal, Philadelphia, Pa. Quality Assurance Directorate.

RAIN TEST PROCEDURES RESEARCH. CORRELATION OF DROPSIZE WITH CLIMATIC REGIONS AND TYPE OF RAIN

Maurice H. Simpson Jun. 1967 36 p refs

(FA-F-1851; Rept.-2; AD-654506)

The report describes investigative research performed at Frankford Arsenal, Philadelphia, Pa., on characteristics of natural rainfall for development of simulation criteria. Rainfall distribution patterns may be typified as characteristic to climatic regions. Furthermore, rainfall drop sizes can also be descriptively characterized to types of rainfall; e.g., thundershowers, heavy showers, or steady rain. Thunderstorms and tropical storms have the largest drop sizes. However, there is small variation in median drop sizes regardless of the climatic region or type of rain. Based on natural rainfall data observed in temperate and tropical regions, no more than 3% of drop sizes exceed 7 mm in diameter with median drop diameters equal to or less than 1.6 mm. Furthermore, for all types of rainfall and for rainfall of all climatic regions, raindrop diameters exhibit the power function relationship of phi approximately equals k(I to the 1/3rd power) where phi is raindrop diameter in mm and I is intensity of rainfall in mm/hr. Author (TAB)

N67-35416# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

THE RELATIONSHIP BETWEEN RADAR SIGNAL ESTIMATORS AND THE DYNAMIC PROCESSES AND MICROSTRUCTURE OF THE RADAR METEOROLOGICAL TARGET [SVYAZ' STATISTICHESKIKH KHARAKTERISTIK RADIOLOKATSIONNOGO SIGNALA S DINAMICHESKIMI PROTSESSAMI I MIKROSTRUKTUROY METEOOB'YEKTA]

A. G. Gorelik, Yu. V. Mel'nichuk, and A. A. Chernikov 13 Apr. 1967 76 p refs Transl. into ENGLISH from Tsentr. Aerol. Observ. Tr. (Moscow), no. 48 1963 p 3–55

(FTD-MT-65-34; TT-65-63971; AD-655016)

A description of the statistical meteorological radar method is given. The full theory of the method is described and it is shown that the radar method can be used to measure wind velocity and the microcharacteristics of precipitation. Formulas are given for use with the radar signal spectrum for determining the mean rate of energy distribution in a turbulent flux, the wind velocity gradient, drop-size distribution, and other parameters. Instruments and observation methods are described. Results are given for observations in clouds of different genera for which the values have been computed. The results of wind observations are described and it is shown that wind direction fluctuations can be separated from wind velocity fluctuations. TAB

N67-35600# Illinois State Water Survey, Urbana.

INVESTIGATION OF THE QUANTITATIVE DETERMINATION OF PRECIPITATION BY RADAR Interim Report, 1 Oct. 1966–31 Mar. 1967

E. A. Mueller, A. L. Sims, and R. Cataneo Jun. 1967 59 p refs

(Contract DA-28-043-AMC-02071(E))

(ECOM-02071-1; IR-1; AD-654444)

The results of a study of the measurement of rainfall by radar at a range of 75 miles are presented. Some of the problems of radar measurements at this range are found to be attenuation and effects of the radar beams vertical extent at distant ranges. The analysis of drop-size data from rains at Flagstaff, Arizona shows that the radar-rainfall relationships there are quite different from those measured elsewhere by the drop camera technique. Results of a study of drop-size distributions from New Jersey and North Carolina are presented. In many respects, the data from these two locations are similar. A paper dealing with the analysis of drop-size data from Florida and Oregon is included as an appendix. Author (TAB)

N67-35636# Naval Ordnance Lab., Corona, Calif.

RAIN INTENSITY—TIME DISTRIBUTIONS

Hubert H. Burroughs 15 Jun. 1967 26 p refs

(NOLC-729; AD-654709)

Measurements of surface rain intensity are made at a relatively few locations around the world. Techniques have been developed

whereby estimates of rain intensity statistics for any location can be obtained from the available climatic data. Graphical representations of such estimates for 46 locations are shown. An estimate of the world-wide average time distribution of rain intensity is based on a weighted average of the estimates for specific locations and a knowledge of the world average annual rainfall. Author (TAB)

N67-35690# National Weather Records Center, Asheville, N. C.
METEOROLOGICAL ROCKET NETWORK FIRINGS, VOLUME III, NUMBER 8
Aug. 1966 229 p

The monthly Meteorological Rocket Data Report for August 1966 contains the wind and temperature measurements from all available meteorological sounding rocket firings, along with computed values for pressure, density, and speed of sound. A brief monthly summary of MRN (Meteorological Rocket Network) rocketsonde data for the current month is also provided. Meteorological rocket sounding data collected at White Sands Missile Range from all cooperating ranges around the world are reduced and documented. R.Li.

N67-35713# Weather Squadron (35th), McChord AFB, Wash. Detachment 4.
AN OBJECTIVE METHOD OF FORECASTING THE OCCURRENCE OF LOW CLOUDS IN THE McCHORD-SEATTLE AREA DURING THE SUMMER MONTHS—A FURTHER STUDY
R. M. Kinzebach May 1967 19 p refs
(AD-654282)

This study is a continuation of a summertime stratus study completed in 1953. In this study an attempt is made to determine a quantitative relationship between the strength of the flow, as determined by selected pressure differences, and the occurrence of cloudiness and ceiling heights at McChord AFB, Washington. The purpose of this study is to make available at 1300P daily an objective forecast giving the probability of occurrence of the ceiling category for McChord AFB between 2200P that night and 1200P the following day. The data used was North Bend-Seattle and Portland-Seattle pressure differences at 1300P for June, July and August, 1958 through 1963 as dependent data, and the same months for 1964 as independent data. Author (TAB)

N67-35781# White Sands Missile Range, N. Mex. Atmospheric Sciences Lab.
SYNOPTIC ANALYSIS OF THE UPPER STRATOSPHERIC DURING THE LATE WINTER STORM PERIOD OF 1966
Ben H. Williams May 1967 32 p refs
(ECOM-5126; AD-654995)

Rocketsonde observations obtained by the Meteorological Rocket Network were used in the investigation of the stratospheric circulation over the western portion of the Northern Hemisphere during 1 - 15 February 1966. Synoptic analyses of 10 and 1-millibar pressure surfaces and vertical time section analyses were used in this study and presented concrete evidence of the temporary breakdown of the winter westerlies. This breakdown was caused by the combined excursions of the Aleutian anticyclone to polar latitudes and the Atlantic anticyclone moving northwestward over the eastern portion of the United States. Author (TAB)

N67-36175# Weather Wing (3rd), Offutt AFB, Nebr.
SOME CONSIDERATIONS IN CHOOSING AN OPTIMUM FORECAST METHOD FOR VARIOUS LENGTH AND TIME SCALES OF CLOUDINESS
Robert A. Derrickson, Jr. Apr. 1967 19 p refs
(TN-17; AD-654313)

The report describes a method of analysis and prognosis which is applicable to cloud forecasting in general. All forecast methods are concerned to some degree with three steps: (1) Collection and organization of an initial data base - this involves data reliability and resolution of the grid or other format. (2) Forecast technique - the equations used for projecting the initial conditions into the future. These equations can range all the way from persistence to a complete physical solution of the problem. (3) Interpretation and display of the results to the customer. This step is concerned with the resolution of the display system and also the interpretation of the results into amount of cloud. The final products resolution and accuracy is dependent on these three steps, acting as filters. This report examines the length - time scale dictates of the atmosphere; the choice of forecast system best suited for a particular job, and finally that stages (1) and (3), above, have a compatible resolution. TAB

N67-36522# Hawaii Inst. of Geophysics, Honolulu.
WEATHER PHENOMENA IN HAWAII Final Report
L. E. Worthley and C. B. H. Lee Jun. 1967 65 p refs
(Contract CwB-11373)
(HIG-67-9)

CONTENTS:

1. SYNOPTIC CLIMATOLOGY OF HAWAII L. E. Worthley p 1–40 refs (See N67-36523 21-20)
2. A PRELIMINARY STUDY OF THUNDERSTORMS IN HAWAII C. B. H. Lee p 41–53 refs (See N67-36524 21-20)

N67-36523# Hawaii Inst. of Geophysics, Honolulu.
SYNOPTIC CLIMATOLOGY OF HAWAII
L. E. Worthley *In its* Weather Phenomena in Hawaii Jun. 1967 p 1–40 refs (See N67-36522 21-20)

Twenty years of manuscript maps of the Honolulu Airport Station, ESSA Weather Bureau, plus ten years of the Historical Map Series are studied to update the synoptic climatology of the Hawaiian Islands. Mean number, maximum and minimum number, and actual number of frontal passages are given for the four major islands by month and by winter season. Frequency of the date of first and last frontal passage of winter, and of the number of frontal passages per month is also given. In addition the number of cyclonic storms (excepting tropical cyclones) occurring within 500 miles of the islands is tabulated. Author

N67-36524# Hawaii Inst. of Geophysics, Honolulu.
A PRELIMINARY STUDY OF THUNDERSTORMS IN HAWAII
C. B. H. Lee *In its* Weather Phenomena in Hawaii Jun. 1967 p 41–53 refs (See N67-36522 21-20)

Analyses of the monthly and diurnal thunderstorm and lightning distributions are presented for ESSA Weather Bureau Airport Stations on the islands of Kauai, Oahu, Maui, and Hawaii. Discussed are some of the energy processes involved in the production of thunderstorms and their apparent relationship to thunderstorms in the Hawaiian Islands. Author

N67-36632 Library of Congress, Washington, D. C. Aerospace Technology Div.
SOVIET AUTOMATIC HYDROMETEOROLOGICAL NETWORK Surveys of Foreign Scientific and Technical Literature
21 Aug. 1967 69 p refs
(ATD-67-29)

A compilation of abstracts is presented which concerns the automation of data handling and processing in meteorology. The abstracts cover such areas as: the development of fully automated weather-data collection and handling networks; facsimile transmission and reception equipment and computer input, processing, and output. C.L.W.

N67-36833 Smiths Industries Ltd., London (England). Aviation Div.
AUTOLANDING—A REVIEW OF PROGRESS TOWARDS LOWER WEATHER MINIMA OPERATIONS
M. G. Henley May 1967 26 p Presented at the 8th Intern. Aeron. Congr., Paris, 29–31 May 1967
(RID-1053)

The in-flight development of the autopilot system on the passenger-carrying Trident aircraft is reviewed in terms of airline experience with the automatic landing system. Flight trials conducted to satisfy the British Air Registration Board requirements for certification are described, and data are given on the automatic landings achieved in practical low weather conditions. The multiplex system of redundancy, which was adopted, is discussed. Known as a fail-steady system, the failure of either subchannel results in complete channel disengagement with little disturbance to the flight path. Triplex autolanding is also discussed briefly. In this method, termed failure survival, a faulty subchannel is outvoted by the other two subchannels and is automatically disengaged, with the channel then reverting to duplex. M.G.J.

21 NAVIGATION

Includes guidance; autopilots; star and planet tracking; inertial platforms; and air traffic control. For related information see also: 07 Communications.

N67-35418# Air Force Missile Development Center, Holloman AFB, N. Mex.
GYROSCOPE STANDARD TORQUE-TO-BALANCE TEST
James F. Russell Jun. 1967 45 p refs
(MDC-TR-67-79; AD-655068)

The Standard Torque-to-Balance (STB) Test for rate-integrating gyroscopes is presented. It is the primary means of evaluating and comparing precision gyroscopes being tested at the Central Inertial Guidance Test Facility (CIGTF). The principal feature of this test method is that data are taken from both clockwise and counter-clockwise table rotations in each of three gyro orientations with no shutdown of the gyro between orientations. The data from these three orientations are then combined to give one solution (with no shutdown uncertainty) for the drift coefficients in the assumed performance model and for the nonorthogonality of the gyro input axis to the table and earth rotation vectors. Variations of the standard test precedure are discussed as are fixed position tests. The data analysis procedure is a single least squares fit of the assumed performance model directly to the data. The magnitude, the standard error, and the statistical significance of each coefficient are determined from the fit. The operating and the shutdown instabilities of each coefficient are computed from the several determinations of each coefficient in an STB test. Snedecor F tests are used to compare the instabilities to the respective standard errors and to each other. Author (TAB)

N67-35560*# McDonnell Aircraft Corp., St. Louis, Mo.
ELECTROMAGNETIC GUIDANCE STUDY
J. H. Lowry Washington, NASA, Sep. 1967 421 p refs
(Contract NAS12-18)
(NASA-CR-865) CFSTI: HC $3.00/MF $0.65 CSCL 17G

Electromagnetic radiators were analyzed to determine their applicability to spacecraft docking procedures. The results of these analyses, indicating the role of mission requirements, structural characteristics, and control system characteristics in establishing docking sensor requirements, are discussed. The capabilities and limitations of several measuring range and range rate techniques are described. These include CW radar systems, pulse radar systems, probes as docking aids, optical radar systems, and nuclear techniques. Methods of angle measurement for docking applications are investigated and include line of sight determination by amplitude or by phase techniques, and target attitude and target attitude rate determination techniques. Requirements of integrated sensor systems for noncooperative missions are examined. Integrated measurement systems which use varying degrees of target cooperation during the docking mission are also described. Results indicate that, although mission requirements vary over a wide spectrum, sensors capable of meeting these requirements can be developed. R.N.A.

N67-35722*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
THE EFFECT OF PLANETARY ALBEDO ON SOLAR ORIENTATION OF SPACECRAFT
Anthony Fontana Washington, NASA, Sep. 1967 27 p refs
(NASA-TN-D-4133) CFSTI: HC $3.00/MF $0.65 CSCL 22A

The analytical expression for the solar orientation error caused by planetary albedo is derived. A typical solar sensor output characteristic is assumed and a computer solution to the analytical expression is obtained. The computer results are presented for a spacecraft in the vicinity of Earth, Venus, Mars, and the Moon. Each planetary body is assumed to be a spherical diffuse reflector with cylindrical shadows and a constant albedo. The data generated herein permit the selection of an appropriate coarse-sensor to fine-sensor switching angle for solar orientation control systems and facilitate the interpretation of solar-referenced scientific experiment data. Author

N67-35739# Societe pour l'Etude et la Realisation d'Engins Balistiques, Courbevoie (France).
STUDY OF ORBITAL GUIDANCE [ETUDE DU GUIDAGE ORBITAL]
Dec. 1964 20 p In FRENCH Prepared for ELDO
(DTA-50-4644, Append. V) CFSTI: HC $3.00/MF $0.65

The initial errors to be expected in the satellite polar orbit after injection by ELDO A-S launch vehicle are briefly reviewed, and the final accuracies desired are indicated. The velocity corrections required are estimated, and a method of orbital adjustment is described. ESRO

N67-35792*# National Aeronautics and Space Administration. Electronics Research Center, Cambridge, Mass.
ALIGNMENT OF INERTIAL SYSTEMS ON A MOVING BASE
Arthur H. Lipton (Ph.D. Thesis—MIT) Washington, NASA, Sep. 1967 183 p refs
(NASA-TN-D-4110) CFSTI: HC $3.00/MF $0.65 CSCL 17G

A unified theory of alignment is developed which is founded on the two considerations common to all alignment procedures: coordinate frames and measurements. All alignment procedures are viewed as a class of non-dimensional, vector-direction-indication problems which effect a transfer of orientation between two coordinate frames. The roles of instrument errors and base motion as fundamental limitations on the alignment accuracy are developed in detail. All performance indices are chosen as angular quantities which are invariant under coordinate transformation. Purely geometric considerations yield a closed form solution for the sensitivity of platform misalignment to the angle between measured vectors. It is also shown that the magnitude of a rotation specified by the arguments of the principal direction cosines is independent of the skewness of the rotated coordinate frame. The magnitude of a rotation specified by Euler angles is found to be almost completely independent of the order of the rotations. Author

N67-35929# Societe pour l'Etude et la Realisation d'Engins Balistiques, Courbevoie (France).
PRELIMINARY STUDY OF INERTIAL GUIDANCE LAWS [ETUDE PRELIMINAIRE DES LOIS DE GUIDAGE INERTIEL]
Dec. 1964 23 p In FRENCH Prepared for ELDO
(DTA-50-4644, Append. III) CFSTI: HC $3.00/MF $0.65

A guidance law is described which can be used to place a satellite into an 8 hr polar orbit or a 24 hr equatorial orbit and where attitude control commands are generated by an on-board inertial guidance computer. Use of a multistage launch vehicle is assumed. ESRO

N67-36634*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
OPLE EXPERIMENT
Charles Laughlin, Gay Hilton, and Richard Lavigne Jun. 1967 61 p refs
(NASA-TM-X-55885; X-733-67-266) CFSTI: HC $3.00/MF $0.65 CSCL 17G

The Omega position location equipment (OPLE) concept is explained, and details are given on an experiment designed to demonstrate the feasibility of using the Omega navigational system in conjunction with synchronous satellites to establish a global location and data collection system. The operational system would consist of an OPLE control center (OCC), a synchronous satellite, and the OPLE platform electronic packages (PEP) working jointly with the Omega network. The Omega system, the satellite transponder, and the OCC and PEP equipments are described in detail, and the operation of the system transmission links and timing sequence is discussed. Platform deployment and systems test plans are outlined. M.G.J.

N67-36670# Royal Aircraft Establishment, Farnborough (England).
SPACECRAFT ATTITUDE CONTROL: BASIC KINEMATICS AND DYNAMICS
W. G. Hughes *In* ESRO Control and Stabilization of Spacecraft. Vol. III: Active Control Systems Jan. 1967 p 1–34 refs (See N67-36669 21-31)

Rigid body kinematics and dynamics are discussed in relation to satellite attitude control problems. Questions of systems of axes, axis transformations, and angular velocities are considered, attention being given to ways of expressing axis transformations in forms suitable for computation. Equations of motion are developed for systems of pivoted rigid bodies, with discussion of the simplifications which can often be used. The free motion of a rigid body is then treated and, finally, equations are developed for small displacements of a rigid body relative to an earth-pointing axis system. Author (ESRO)

N67-36675# Royal Aircraft Establishment, Farnborough (England).
ATTITUDE CONTROL BY PURE JET SYSTEMS
K. J. O'Mahony *In* ESRO Control and Stabilization of Spacecraft. Vol. III: Active Control Systems Jan. 1967 p 129–154 refs (See N67-36669 21-31)

The more common techniques and methods of analysis for attitude control systems using on–off jet thrust control are discussed. Methods of locking on to the satellite attitude reference are first mentioned. A detailed account follows of the principles of on–off jet systems, including consideration of phase–plane plots, methods of producing the desired switching boundary, and reduction of limit cycling by the introduction of an angular position dead-zone. The drived rate or thrust feedback system is described briefly. Analytical techniques for studying the stability of linear and nonlinear systems are given. The Ranger Block II control system is reviewed briefly. Author (ESRO)

22 NUCLEAR ENGINEERING

Includes nuclear reactors and nuclear heat sources used for propulsion and auxiliary power. For basic research see: 24 Physics, Atomic, Molecular, and Nuclear. For related information see also: 03 Auxiliary Systems; and 28 Propulsion Systems.

N67-35317 Kernforschungsanlage, Juelich (West Germany).
DISCUSSION CONFERENCE ABOUT NEUTRON PHYSICS ON RESEARCH REACTORS [DISKUSSIONSTAGUNG UEBER NEUTRONENPHYSIK AN FORSCHUNGSREAKTOREN]
May 1967 254 p refs In GERMAN Meeting held in Juelich, West Germany, 25–28 Apr. 1967
(JUL-CONF-1)

A survey of German research activities on nuclear and solid-state body physics is presented that covers recent work in reactor centers. The following subjects are discussed: nuclear fission with reactor neutrons; neutron capture reactions; absorption and scattering cross sections of neutrons; neutron spectroscopy; structural analyses on crystals; diffusion and small angle scattering; and reports on the German-French reactor project in Grenoble, France. Translat. by G.G.

N67-35388# Oak Ridge National Lab., Tenn. Reactor Div.
PREIRRADIATION DATA FOR THE FUEL SPECIMENS FOR THE ARMY PM FUEL EXPERIMENT IN THE ORR PRESSURIZED-WATER LOOP
V. O. Haynes and A. E. Richt Jun. 1967 137 p refs
(Contract W-7405-ENG-26)
(ORNL-TM-1783) CFSTI: HC $3.00/MF $0.65

The preirradiation condition of fuel specimens for the Army PM (Portable-Medium) Reactor fuel experiment in the Oak Ridge Research Reactor pressurized-water loop is described. Various instruments and equipment used to perform the measurements and the analytical techniques are also described. Complete information is given for the specimens irradiated for an extended time and, where available, for other specimens fabricated for the fuel irradiation phase of the Army PM advanced-fuel development program. Author (NSA)

N67-35389# Oak Ridge National Lab., Tenn. Neutron Physics Div.
CRITICAL LATTICES OF HIGH FLUX ISOTOPE REACTOR FUEL ELEMENTS
E. B. Johnson 20 Mar. 1967 10 p ref
(Contract W-7405-ENG-26)
(ORNL-TM-1808) CFSTI: HC $3.00/MF $0.65

Lattices of High Flux Isotope Reactor (HFIR) fuel elements were assembled in order to determine the critical spacing between elements when moderated and reflected by water. It was found that seven elements spaced 6.37 in. in a triangular pattern were critical when submerged. Seven outer annuli in the same pattern were critical when separated 1.50 in., and seven inner annuli were subcritical even when in contact. Author (NSA)

N67-35439# Oak Ridge National Lab., Tenn.
NUCLEAR INSTRUMENT MODULE MAINTENANCE MANUAL. PART I: CHAMBER VOLTAGE AND TEST UNIT, ORNL MODE Q-2601
J. L. Anderson 13 Apr. 1967 16 p
(Contract W-7405-ENG-26)
(ORNL-TM-1638) CFSTI: HC $3.00/MF $0.65

A Chamber Voltage Monitor and Test Unit, a special purpose module, was designed to supply signals for testing the response

of parts of a reactor safety system utilizing ORNL modular reactor instrumentation, series Q-2600. The unit supplies a calibrated current ramp at two different rates for checking the response and approximate calibration of both neutron flux level and rate-of-change-of-flux-level trips and associated signal amplifiers, an adjustable steady-state test current, and a circuit which continuously monitors ion chamber polarizing voltage. The circuit, application, maintenance procedures, and acceptance tests for the unit are described. Author (NSA)

N67-35528# Japan Atomic Energy Research Inst., Tokyo.
STUDY ON SLIGHT LEAKAGE FROM A REACTOR CONTAINMENT VESSEL
Jun. 1967 38 p refs Transl. into ENGLISH from J. Japan Soc. Mech. Engr., v. 68, no. 560, Sep. 1965 p 1321–1332
(NSJ-TR-87)

Test specimens with leak holes closely resembling welding defects were prepared from structural steel, stainless steel, and aluminum. Leakage was determined by pressure measurements at temperatures from 20° to 200°C and at vacuum pressures from 1 to 100 atm. Helium, carbon dioxide, nitrogen, and water were used as the test media. It was found that the cross section of the small leaks was closer to a slit than a circular hole, but a circular cross section is approached with increasing size of the leak. The flow is molecular for small holes, but it becomes viscous as the size of the leak increases. Within the range from 20° to 200°C the effect of temperature on the flow rate is negligible. The leakage of water through a minute hole is quite different from that of gases, primarily because evaporation occurs somewhere along the length of the leak hole, which results in a mixed two-phase flow. In smaller holes the vapor phase predominates, in larger holes the liquid phase. K.W.

N67-35633# General Dynamics Corp., San Diego, Calif. John Jay Hopkins Lab. for Pure and Applied Science.
INTEGRAL NEUTRON THERMALIZATION Quarterly Progress Report, Period Ending Dec. 31, 1966
J. R. Beyster, H. Antunez, G. Borgonovi, W. Brouwer, G. Carriveau et al 25 Jan. 1967 173 p refs Also includes GA-7581 and GA-7608
(Contract AT(04-3)-167)
(GA-7673) CFSTI: HC $3.00/MF $0.65

Research for the development of thermal scattering kernels is presented. Studies on H_2O have continued and include the corrections for multiple scattering to the double differential data. The angular scattering measurements performed on H_2O have been summarized. The total cross section measurements in H_2O have been reanalyzed and compared with the predictions of the various theoretical models. Further angular scattering measurements have been made on zirconium hydride at elevated temperatures. Thermal spectrum measurements have been made in Be metal at liquid N_2 temperatures as a function of position. The position dependent spectral measurements in ^{238}U in the resonance energy region are analyzed and experimental and theoretical discrepancies are encountered. An improved theoretical model for benzene is described. NSA

N67-35634# Argonne National Lab., Ill. Reactor Engineering Div.
HYDRODYNAMICS OF A NEW CONCEPT OF PRIMARY CONTAINMENT BY ENERGY ABSORPTION
H. C. Sorensen and S. H. Fistedis Dec. 1966 141 p refs
(Contract W-31-109-ENG-38)
(ANL-7214) CFSTI: HC $3.00/MF $0.65

To determine the effect that the destructive component of a nuclear accident produces on a primary containment structure, a fluid dynamical analysis is made for an idealized reactor system having spherical symmetry. This structure consists of the utilization of the concrete biological shield as an energy-absorbing device. For this purpose, unbonded, unstressed, high-strength steel strands are embedded in the biological shield. The new containment concept is based on the energy-absorbing capability of the strands. The partial differential equations describing the fluid motion are based upon the von Neumann–Richtmeyer artificial-viscosity technique and are presented in Lagrangian form. A numerical solution based upon finite-difference approximations of these partial differential equations is obtained by the use of a CDC-3600 digital computer. All computer programs used in obtaining the numerical solution are written in FORTRAN IV computer language. A solution for an ideal reactor system that does not include the reactor vessel is given along with a solution for the same ideal reactor system but with the reactor vessel included. In each case, the effect that the destructive component produces on the concrete containment structure is determined from the computer results and is discussed. The results of the two solutions are then compared. Suggestions for improvements in the analysis and suggestions for future work are also mentioned. Author (NSA)

N67-35761* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
VULCAN—A DEPLETION PROGRAM FOR USE WITH INDEPENDENT ONE-DIMENSIONAL SPATIAL CALCULATIONS
John L. Anderson, Jr. Washington, NASA, Sep. 1967 72 p refs
(NASA-TN-D-4151) CFSTI: $3.00 CSCL 18K

A digital computer depletion program, VULCAN, which treats the time behavior of nuclide concentrations in a nuclear reactor, is described. This depletion program is suitable for use with any multigroup one-dimensional spatial solution; that is, it is independent of the actual generating source of cross sections or fluxes. This flexibility allows any space-energy calculational sequence to be extended, without alteration, to include a depletion stage. The depletion calculation is performed for each mesh interval, and an averaging process is used to reduce the number of regions for which new atom densities are required. The depletion equations for several classes of nuclides are shown and cast into forms solvable by a computer. Data input instructions, a sample problem, and a FORTRAN IV listing of the program are included. VULCAN, written for an IBM 7094, relies entirely on fast memory computer storage (32K). Author

N67-35762*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
A DIGITAL COMPUTER PROGRAM FOR CALCULATING STEADY TEMPERATURE AND DENSITY DISTRIBUTIONS IN A GAS CONTAINING HEAT SOURCES
Harry W. Davison Washington, NASA, Sep. 1967 42 p refs
(NASA-TN-D-4135) CFSTI: HC $3.00/MF $0.65 CSCL 18K

A digital computer program that allows calculation of axial temperature and density distributions in a stagnant gas enclosed within an annulus is presented. The program, called STADDIG, is written in FORTRAN IV language for the IBM 7094 computer and is based on a steady-state one-dimensional (radial) heat-transfer calculation using cylindrical coordinates. The gas density is related to the gas temperature through the perfect gas law. The program allows for conduction across the gas and across the container walls. Heat is dissipated from the container walls by forced-convection cooling with an incompressible coolant. Heat sources are included in the coolant, the gas, and the container walls. The axial distribution of gas temperature and density is determined by successive radial heat-transfer calculations at different axial positions. Axial heat conduction is neglected. A typical problem containing 20 axial increments requires about 4 seconds of running time when the gas densities and thermal conductivites are required to converge within 0.1 and 1 percent, respectively. Changing the convergence requirements has no appreciable influence on the problem running time. Author

N67-35767# Coast Guard, Baltimore, Md. Field Testing and Development Center.
SNAP-7A ISOTOPIC POWER SUPPLY FOR BUOYS
K. D. Urfer 28 Jun. 1967 10 p
(FTDC-437, Addend. 1; AD-654187)

This addendum to Field Testing and Development Center Report No. 437 (AD-632 991) documents the testing of the SNAP-7A generator for the period between the date of the basic report and the termination of testing. Author (TAB)

N67-35780# Aktiebolaget Atomenergi, Stockholm (Sweden).
MEASUREMENTS OF THE REACTIVITY PROPERTIES OF THE AGESTA NUCLEAR POWER REACTOR AT ZERO POWER
G. Bernander Jul. 1967 44 p refs
(AE-289) CFSTI: HC$3.00/MF$0.65

Reactivity Moderator level and temperature coefficients, and control rod differential reactivity values were determined at zero power by means of period measurements. Moderator level coefficient and the corresponding critical levels were measured for the 32, 68 and 136 fuel assembly cores at room temperature, with and without control rods. From these results the values of control rods were derived. Hetero program calculations give up to 15% lower values than the experimental results. The cold fresh core has an excess reactivity of 9.0±0.2%. The temperature coefficient and differential control rod values were measured for the fully loaded core with filled tank in the temperature range between 30 and 210°C. Critical positions as a function of temperature were obtained for the corresponding control rod groups. The relative increase in control rod effectiveness with a temperature change from 20 to 220°C has been estimated to be 0.29±0.06. Author

N67-35787# Bettis Atomic Power Lab., Pittsburgh, Pa.
DEFORMATION AND COLLAPSE OF FUEL ROD CLADDING DUE TO EXTERNAL PRESSURE
D. S. Griffin Jan. 1967 46 p refs
(Contract AT(11-1)GEN-14)
(WAPD-TM-591) CFSTI: HC$3.00/MF$0.65

Approximate methods are given for analyzing the effects of external pressure on Zircaloy fuel rod cladding. The structural behavior of the clad is idealized to be independent of the behavior of the fuel. Phenomena considered include inelastic and creep collapse, inelastic deformation (ovality), diametral shrinkage, dimpling, and axial wrinkling. Comparisons with experimental results are given where available. Author (NSA)

N67-35788# Bettis Atomic Power Lab., Pittsburgh, Pa.
XENON SPATIAL STABILITY IN LARGE SEED-BLANKET REACTORS
T. R. England, G. L. Hartfield, and R. K. Deremer Apr. 1967 186 p refs
(Contract AT(11-1)-GEN-14)
(WAPD-TM-606) CFSTI: HC$3.00/MF$0.65

A general modal method of analysis for spatial instabilities, which can utilize the multidimensional diffusion programs normally used in reactor design, is developed. The pertinent equations and the methods of their application are discussed and developed with an exposition oriented toward the needs and tools of the nuclear designer. Moderator temperature and fuel temperature (Doppler) feedback effects are included. The methods are practical, and are applicable to any reactor for any nuclide chain. The validity of the analytical methods is documented by: exact one-dimensional studies, comparisons with observed variations in the stability of the Shippingport reactor, and LSBR analog studies in two and three dimensions. The results of extensive LSBR calculations and analog studies are included. The effects of geometrical configuration, power distribution, fuel types and compositions, temperature feedback, higher order transport, and reactor lifetime on stability are examined. Reactor stability for nuclides other than ^{135}Xe is also discussed. It is found in both digital and analog studies that the moderator and Doppler reactivity coefficients are strong stabilizing influences. All studies quantitatively agree. The LSBR designs would be stable to spatial Xe oscillations throughout life primarily because of the Doppler coefficient and yield advantage inherent to the ^{232}Th-^{233}U fuel chain. Author (NSA)

N67-35789# Bettis Atomic Power Lab., Pittsburgh, Pa.
FRACTURE OF CYLINDRICAL FUEL ROD CLADDING DUE TO PLASTIC INSTABILITY
W. J. O'Donnell Apr. 1967 14 p refs
(Contract AT(11-1)-GEN-14)
(WAPD-TM-651) CFSTI: HC$3.00/MF$0.65

A failure mechanism is described for the cladding of cylindrical fuel rods whereby fracture occurs as a consequence of plastic instability induced by fuel swelling. The loss of work hardening capacity from irradiation damage reduces the nominal failure strain by an order of magnitude, resulting in fracture of nominal strains of about 2% with Zircaloy cladding. When recently reported in-pile fuel rod failure experiments were compared with theoretical predictions, good agreement resulted. The results provide a basis for setting allowable clad strain design limits. It was carried out in support of the LWB–LSBR fuel element development effort. Author (NSA)

N67-35790# Bettis Atomic Power Lab., Pittsburgh, Pa.
A PROCEDURE FOR ANALYSIS OF ZIRCALOY-CLAD BULK OXIDE RODS USING THE CYGRO-1 COMPUTER PROGRAM
E. Duncombe Apr. 1967 58 p refs
(Contract AT(11-1)-GEN-14)
(WAPD-TM-583, Addend. No. 1) CFSTI: HC$3.00/MF$0.65

Procedures are specified for using the CYGRO-1 computer program to evaluate the results of irradiation tests of Zircaloy-clad bulk oxide fuel rods and to determine the adequacy of related fuel rod designs. The procedures are discussed in detail and methods are described for handling worst-case conditions for use in fuel rod design, as well as the best estimate of conditions used for evaluation of tests. These procedures were set up as part of the LSBR-LWB development program. Author (NSA)

N67-35832# Atomic Energy of Canada, Ltd., Chalk River (Ontario).
DETERMINATION OF LATTICE PARAMETERS USING A FEW RODS
A. Okazaki and D. S. Craig Mar. 1967 83 p refs
(AECL-2593) CFSTI: HC$3.00/MF$0.65

A study has been made to determine whether lattice parameters of natural U, heavy water-moderated lattices can be obtained using as few as seven test fuel rods placed at the center of a driver or reference lattice of known properties. Up to seven test rods were substituted successively for reference rods and the critical height changes measured. Measurements were made for fuel clusters of natural UO_2 and U metal with D_2O, He and organic (HB-40) coolants, in 18 and 22 cm triangular pitch lattices. A two-group heterogeneous reactor calculation program (MICRETE) was used to determine the bucklings of the test rod lattices from the critical height changes. For D_2O-cooled rods the values are in good agreement with those obtained by conventional flux mapping in lattices containing a large number of test rods, even for buckling differences of 6 m^{-2} between test and reference lattices. The agreement is worse for He and HB-40 cooled rods. Measurements were made of the neutron flux distribution, Westcott spectrum parameters r and T, initial conversion ratio, and fast fission ratio using seven test rods and in general the results are in agreement with those made in lattices containing a large number of rods. Author (NSA)

N67-35840# Los Alamos Scientific Lab., N. Mex.
OPERATION OF THE PLUTONIUM-FUELED FAST REACTOR LAMPRE
R. E. Peterson and R. L. Cubitt [1967] 14 p refs Presented at the Natl. Topical Meeting on Fast Reactors, San Francisco, Apr. 1967
(LA-DC-8398; CONF-670413-2; ANS-101) CFSTI: HC $3.00/MF $0.65

Adequate coolant purity was maintained in the LAMPRE system so that a refractory metal container for the fuel could be satisfactorily used. N from the atmosphere was observed to diffuse into the coolant loop through the pipe walls, which operated at 450 to 650°C; the N concentration in the gas space above the Na was controlled by periodic flushing, and no ill effects attributable to the N were observed. During the course of the experiment, fission products and Pu were released into the coolant loop. This had only a minor effect on the established procedures for reactor operation, fuel handling, etc. The distribution of fission products in the system was not examined in detail, because not all of the loop was accessible to γ scanning equipment. Where measurements could be made, the results—particularly with respect to Cs—are consistent with fission product transport and distribution observed in laboratory experiments. A major part of the core structure, and some of the coolant loop, was disassembled after the conclusion of the reactor experiment. This was accomplished without particular difficulty. The level of dispersible Pu contamination was lower than had been expected. In the hot trap system, Pu contamination was firmly fixed on the pipe walls; sections of these components were removed from the loop without any special techniques to prevent the spread of radioactive materials. The larger sections of gas piping attached to the top of the reactor vessel contained detectable levels of Pu, but conventional bagging techniques were adequate to permit uneventful disassembly of the system. Smaller gas lines connected to the fuel charging machine were safely removed without bagging. Author (NSA)

N67-35883# Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.
SNAPTRAN-2 DESTRUCTIVE TEST RESULTS
W. E. Kessler and L. N. Weydert, Jr., ed. Jan. 1967 128 p refs
(Contract AT(10-1)-205)
(IDO-17194) CFSTI: HC $3.00/MF $0.65

The nuclear, mechanical and radiological behavior of the SNAPTRAN-2 reactor when subjected to a rapid reactivity addition of 5.1 dollars is described. The total energy release was limited to 54 MW-sec primarily by the thermally induced negative reactivity feedback characteristic of the Zr–hydride–U fuel. Rapid core expansion caused by H_2 pressure buildup took place when the fuel temperature reached 1900°F. During dispersal of the burning fuel and H_2, approximately 20% of the fission products was released to the atmosphere. Radiological measurements indicated that the potential six-hour accumulative gamma exposure resulting from the test was less than 10 R at 100 m from the reactor. Author (NSA)

N67-35908# Los Alamos Scientific Lab., N. Mex.
CHARACTERISTICS OF THE RADIOACTIVE POLLUTANT FROM GROUND TESTING OF NUCLEAR PROPULSION REACTORS
Richard W. Henderson [1967] 11 p refs Presented at the Intern. Atomic Energy Agency Symp. on Instr. and Tech. for the Assessment of Airborne Radioactivity in Nucl. Operations, Vienna
(Contract W-7405-ENG-36)
(LA-DC-8524; CONF-670704-3) CFSTI: HC $3.00/MF $0.65

The radioactive pollutant resulting from the ground testing of nuclear propulsion reactors is initially released as a distributed vertical line source. The resultant ground level contamination pattern is much like what would be expected from a two point release; one at ground level and a second at about 2000 m above ground. The material in the cloud is composed of volatile fission products or the daughters of volatile fission products. The major contributors to the activity are in three mass groups, 89 to 93, 129 to 135, and 140 to 144. The Sr and Y have been measured on the ground and aloft, and tin and Sb have been measured in the cloud aloft as well. In the third group, Ba and La have been measured on the ground and aloft, and Ce has been measured in the aircraft samples. It appears that the discontinuity between the last two groups is due to Xe remaining in the reactor. The polutant, at distance, behaves as two clouds, one made up of gaseous material and the second of particulate. The activities of the two remain in a nearly constant ratio out to 25 miles along the hot line. It appears that the gaseous cloud suffers more lateral diffusion than the particulate fraction. The particulate fraction appears to be composed of particles principally in the submicron range. Depletion of the cloud seems to be largely by turbulent impaction or sorption. Correlation between airborne levels and ground concentrations is poor. Deposition velocities which have been measured are statistical in nature and show a log normal distribution with a mean of 0.5 cm/sec and a geometric standard deviation of about 10. The concept of a constant deposition velocity is most probably not valid. Direct measurements of the ground level dose due to cloud passage and ground deposition tend to confirm the presence of the precursors to the isotopes measured but as yet yield no quantitative data in this regard. Author (NSA)

N67-36008# Oak Ridge National Lab., Tenn.
USE OF RESEARCH REACTORS IN RADIATION DAMAGE STUDIES AND IN SOLID STATE AND METAL PHYSICS
D. S. Billington 1967 35 p refs Presented at Intern. Conf. on Reactor Res. Util. and Reactor Math., Mexico City
(Contract W-7405-ENG-26)
(ORNL-P-3038; CONF-670501-11) CFSTI: HC $3.00/MF $0.65

Research reactors are unique tools that have an essential role not only in radiation damage studies but also in defect solid state research, neutron scattering studies, and techniques that support solid state research such as isotope production and activation analysis. Results of radiation damage experiments utilizing the BSR and the ORR are described. NSA

N67-36018# Oak Ridge National Lab., Tenn.
COMPUTER CODE TONG FOR ZERO-DIMENSIONAL REACTOR DEPLETION CALCULATIONS
D. R. Vondy and T. B. Fower Jun. 1967 131 p refs
(Contract W-7405-ENG-26)
(ORNL-TM-1633) CFSTI: HC $3.00/MF $0.65

A multigroup point-depletion calculation was programmed (FORTRAN II) for the IBM-7090. The 68-group fast-neutron code GAM, which will process resonance parameters, and the 30-group thermal-neutron one-dimensional code THERMOS were modified and incorporated in the program, which is designated TONG. The NUCY code technique was used for an explicit solution of any set of interlocked nuclide chain equations. The program tape can be used to prepare MODRIC or EXTERMINATOR cross sections or to make individual GAM or THERMOS calculations. A number of modifications were made in the GAM and THERMOS programs to increase flexibility. Fuel-cycle costs may be determined and intermittent once-through fuel movement, or scatter refueling, can be considered. Author (NSA)

N67-36047# Japan Atomic Energy Research Inst., Tokyo.
DIRECT SUBSTITUTION OF PLUTONIUM IN COMMERCIAL BOILING WATER REACTOR
Sigeru Yasukawa, Kunihiko Uematu, and Ryozo Yumoto Jul. 1966 40 p refs In JAPANESE and ENGLISH
(JAERI-1123)

Some fundamental problems, which occur when Pu fuel is substituted into a boiling water reactor core, are analyzed by a

nuclear-thermo-hydromechanics coupled calculation. Results obtained are: Pu fuel uses in thermal reactors can be divided into the direct substitution, the burner utilization, the breeder utilization, the crossover system, and the Pu–Th system. The possibility of direct substitution of Pu into commercial boiling water reactors has been confirmed by analysis of the characteristics of these cores. The most suitable lattice for Pu use is probably a slightly overmoderated one because of the negative void reactivity effect at initial burnup. The lattice should be moderated to prevent recovery of this negative void reactivity with fuel burnup. NSA

N67-38067# Oak Ridge National Lab., Tenn.
MATERIALS DEVELOPMENT FOR MOLTEN-SALT BREEDER REACTORS
H. E. McCoy, Jr., and J. R. Weir, Jr. Jun. 1967 89 p refs
(Contract W-7405-ENG-26)
(ORNL-TM-1854) CFSTI: HC $3.00/MF $0.65

The materials development program to ensure the successful construction and operation of a molten-salt breeder reactor is discussed. The proposed reactor is a two-region system utilizing a U-bearing fluoride fuel salt and a Th-bearing fluoride blanket salt. A third lower melting fluoride salt will be used as a coolant for transferring the heat from the fuel and blanket salts to the supercritical steam. The primary structural materials are graphite and modified Hastelloy N. The individual fuel cells will be constructed of graphite tubes. These tubes must withstand neutron doses of the order of 10^{23} neutrons/cm^2 and must have very low permeability to gases (because of ^{135}Xe entrapment) and fused salts. These requirements mean that a graphite that is slightly better than any currently available is required. We have described what graphites are available and their respective properties. Action for obtaining improved grades of graphite is proposed with a test program for evaluating these new products. Modified Hastelloy N will be used in all parts of the system except the reactor core. Since standard Hastelloy N is embrittled at elevated temperatures by neutron irradiation, it has been necessary to modify the composition of the alloy with a small addition of Ti. The program necessary for fully developing this modified alloy as an engineering material is described. An integral part of the proposed system is a joint between the tubular graphite fuel channels and the modified Hastelloy N. Brazing alloys have been developed specifically for this job and a reasonable design for the joint has been made. The integrity of the joint must be demonstrated by engineering tests. Author

N67-38144# Japan Atomic Energy Research Inst., Tokyo.
JPDR THERMAL AND HYDRAULIC CHARACTERISTICS MEASURED BY AN INSTRUMENTED FUEL ASSEMBLY (IFA) AND THEIR ANALYSES BY A COMPUTER CODE "JP-HYDRO"
Jul. 1967 21 p refs
(JAERI-1136) CFSTI: HC $3.00/MF $0.65

The incore thermal and hydraulic characteristics of JPDR were measured, using the instrumented fuel assembly (IFA) with two flowmeters and six thermocouples for measuring the channel coolant flow rate, exit steam quality and subcooling as a function of the reactor power. In addition, the method for calculating the core average exit steam quality and total circulation flow rate was developed by combining one-point measured values in the X-Y plane and the JP-Hydro code used for the natural or forced circulation boiling loop for a multi-channel and multi-riser. The hydraulic model for the IFA channel was prepared by modification of that of the standard fuel channel. The results are as follows: (1) Total circulation flow rate at the full power is about 1,625 t/hr. (2) Estimated carryunder steam quality is proportional to reactor power, and its ratio to the exit steam quality is approximately 0.2. Author

N67-38185# Atomic Energy of Canada, Ltd., Chalk River (Ontario).
FABRICATION OF UO_2–PuO_2 AND ThO_2–PuO_2 EXPERIMENTAL FUEL
A. T. Jaffs, R. R. Boucher, and L. R. Norlock Feb. 1967 17 p refs Presented at the IAEA Symp., on the Use of Plutonium as a Reactor Fuel, Brussels, 13–17 Mar. 1967
(AECL-2675; CONF-670306-5) Available from Atomic Energy of Canada, Ltd., Chalk River: $0.50

Fabrication procedures are described for preparation of an experimental charge of eleven sintered pellet fuel elements for a pressurized-water test loop in the NRX reactor. Six elements of mechanically mixed UO_2–PuO_2 plus two enriched UO_2 reference elements were fabricated by two alternative routes to permit comparison of performance during operation. The two alternative processes were conventional H_2 sintering at 1600°C and a low-temperature route starting with hyperstoichiometric mixed oxides and using Ar–10%H_2 as the reducing atmosphere. Three elements containing mechanically mixed ThO_2–PuO_2 were fabricated by a conventional high-temperature sintering route to an average pellet density of 9.6 g cm^{-3}. PuO_2 contents for these elements ranged up to 1.93 wt % and all elements were of fuel length (15 cm), clad in Zircaloy-2 of 2.03 cm OD. Author (NSA)

N67-38228*# Farnham (Frank C.) Co., Philadelphia, Pa.
ELECTRICITY DIRECTLY FROM ATOMIC ENERGY [ELEKTRICITET DIREKTE FRA ATOMENERGIEN]
Eric Strom Pedersen Washington, NASA, Jul. 1967 26 p refs Transl. into ENGLISH from the Danish Rept. RISO-M-399, 10 May 1966 p 1–38
(Contract NASw-1497)
(NASA-TT-F-10860; RISO-M-399) CSCL 18N

The production of electricity directly from atomic energy without the use of pumps or turbines is described. This is possible by the use of magnetohydrodynamic thermoelectric, and thermionic devices used in conjunction with a nuclear reactor or radioisotopes as heat sources. The principles of these three direct conversion methods are explained, and some of the problems to be solved before they become important as power sources are discussed. Present and future systems are described. Author

N67-38240# General Electric Co., Sunnyvale, Calif. Advanced Products Operation.
DESIGN AND TESTING OF SOLENOID AND INSTRUMENT LEAD CONNECTOR FOR USE IN SEFOR REACTOR VESSEL
E. R. Craig, R. H. Fulton, and J. J. Damon Mar. 1967 26 p
(Contract AT(04-3)-540)
(GEAP-5307) CFSTI: HC $3.00/MF $0.65

The design and testing of a multipin lead connector for the SEFOR instrumented fuel assembly and the testing of a solenoid for the instrumented fuel assembly lifting fixture are described. Tests in a Na-vapor Ar environment at temperatures up to 400°F demonstrated that the operational performance of the components would meet or exceed the anticipated requirements for the SEFOR operation. Author (NSA)

N67-38289# Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik.
PROSPECTS OF PLUTONIUM FUELED FAST BREEDERS
D. Gupta, W. Haeffele, P. Jansen, and J. Seetzen Feb. 1967 21 p refs
(KFK-569)

Various aspects of the Pu fueled fast breeder reactors are considered. Both the short-term and long-term criteria for Pu fast reactor systems are examined. Comparisons of various types of fast Pu breeders are given. NSA

N67-38291# Comitato Nazionale per l'Energia Nucleare, Rome (Italy).
TRANSPORT EQUIVALENT NEUTRON DIFFUSION IN VOID REGIONS. APPLICATION OF A DIFFUSION CODE TO A CORE CONTAINING NOT-HOMOGENIZED CYLINDRICAL CAVITIES

M. Michelini 1966 49 p refs
(RT/FI-(66)44)

A formalism for calculating the effects of large cylindrical cavities in a reactor core is outlined, and results obtained using the formalism are compared with measurements made in the zero-power reactor RITMO. A general formulation of the diffusion coefficient is derived from transport theory, and a formula is obtained for the diffusion coefficient in cylindrical cavities. NSA

N67-36397# Bettis Atomic Power Lab., Pittsburgh, Pa.
FABRICATION OF SOLID, ANNULAR, AND DISHED-END CERAMIC FUEL PELLETS
R. G. R. Johnson and H. H. Crain May 1967 88 p refs
(Contract AT(11-1)-GEN-14)
(WAPD-TM-578) CFSTI: HC $3.00/MF $0.65

An investigation was performed as part of the LSBR fuel development program to determine process parameters for the production of cylindrical seed and blanket (ThO_2) fuel pellets by dry pressing and sintering. A double-firing technique was used to ensure complete U homogeneity in the finished seed pellets. After the first firing (calcination of the raw powders to form solid solutions), the resulting oxide "cake" was comminuted in a fluid energy mill to a highly sinterable, micron-sized powder. Pellets were fabricated by conventional dry pressing of an agglomerated powder containing a wax binder. Green pellets were densified by a high-temperature H_2 sinter. Fuel types investigated included two UO_2–ZrO_2 compositions (28 and 36 wt % UO_2), two UO_2–ThO_2 compositions (7.6 and 21 wt % UO_2), 7.5 wt % UO_2–6.7 wt % CaO–ZrO_2 and plain ThO_2. The results demonstrated the feasibility of fabricating these compositions of ceramic fuel into pellets by the processes employed. Author (NSA)

N67-36405# Atomic Energy of Canada, Ltd., Chalk River (Ontario).
DRYOUT IN BOILING WATER REACTORS
G. D. McPherson Apr. 1967 12 p
(AECL-2876; CONF-670522-5) Available from Atomic Energy of Canada, Ltd., Chalk River: $0.50

The development of fuel assemblies to operate at high coolant quality should improve the economics of Canadian boiling water reactors. Present practice is to operate at conditions at which the sheath is completely wetted. The combination of design parameters at which dry sheath operation (dryout) would begin represents an important boundary to the reactor designer. Experimental studies have revealed what factors affect dryout and many attempts have been made to relate these factors. Author (NSA)

N67-36488# National Inst. for Research in Nuclear Science, Harwell (England). Rutherford High Energy Lab.
NIMROD OPERATION AND DEVELOPMENT Quarterly Report, Sep. 20–Dec. 31, 1966
D. E. Gray Feb. 1967 12 p refs
(RHEL/R-142; QR-1) CFSTI: HC $3.00/MF $0.65

Details are given of the operation of Nimrod over the period. Machine development included installation of a beam servo system for damping coherent vertical beam oscillations in the (1–Q) mode. The quality of flat-top spill was materially improved by the introduction of a noise servo spill system, and by a method of reducing rf structure. Equipment has been commissioned to reduce the 2nd harmonic ripple on the magnet waveform. The experimental program is outlined. NSA

N67-36510# Argonne National Lab., Ill.
ADDENDUM—OUT-OF-PILE EXPERIMENTS ON POWER EXCURSIONS [ADDITIF—EXPERIENCE HORS-PILE SUR LES EXCURSIONS DE PUISSANCE]
S. Elberg and M. Nyer Apr. 1967 15 p Transl. into ENGLISH of a Paper Presented at the Symp. on Heat Exchange during Transients, Cadarache, France, 26–29 Apr. 1966
(ANL-TRANS-468; CONF-660455-2) CFSTI: HC $3.00/MF $0.65

The results of out-of-pile power excursion experiments are presented. The flow techniques, relative pressurizer air pressure, water height above channel, average flux, average energy dissipated in heater plates, and adiabatic heating of plates are tabulated. NSA

N67-36511# Oak Ridge National Lab., Tenn.
INSTRUMENTATION AND CONTROLS DEVELOPMENT FOR MOLTEN-SALT BREEDER REACTORS
J. R. Tallackson, R. L. Moore, and S. J. Ditto 22 May 1967 33 p refs
(Contract W-7405-ENG-26)
(ORNL-TM-1856) CFSTI: HC $3.00/MF $0.65

Instrumentation in use in the MSRE provides a good basis for development of the instrumentation for large molten-salt breeder reactors. The development would involve primarily the testing and improvement of existing instrument components and systems. New or much improved devices are required for measuring flows and pressures of molten salts in the fuel and blanket circulating systems. Author (NSA)

N67-36514# Brookhaven National Lab., Upton, N. Y.
USES OF RESEARCH REACTORS FOR RESEARCH INTO THE STRUCTURE OF LIQUIDS AND SOLIDS
Harry Palevsky 12 May 1967 41 p refs Presented at the Intern. Conf. on Res. Reactor Utilization and Reactor Math., Mexico City, 2–4 May 1967
(BNL-11401; CONF-670501-12) CFSTI: HC $3.00/MF $0.65

The uses of research reactors for research into the structure of liquids and solids and a development of the principles involved in the research were presented. Author (NSA)

N67-36516# General Electric Co., Pleasanton, Calif. Nuclear Technology Dept.
POWER REACTOR HIGH PERFORMANCE UO_2 PROGRAM Progress Report, Jan. 1–Mar. 31, 1967
E. A. Lees Apr. 1967 29 p refs Prepared jointly with EURATOM
(Contract AT(04-3)-189)
(GEAP-5487; EURAEC-1860; PR-3) CFSTI: HC $3.00/MF $0.65

Irradiation testing of six fuel assemblies of high performance UO_2 was performed in the Big Rock Point Power Reactor. The fuel rods were clad with Zircaloy-2 tubing. Results of computer calculations of cladding and UO_2 temperature, and thermal expansion are given. The results of critical heat flux analysis are tabulated. The equipment necessary to conduct the tests is being fabricated. NSA

N67-36519# Argonne National Lab., Ill.
OUT-OF-PILE EXPERIMENTS ON POWER EXCURSIONS
S. Elberg and M. Nyer [1966] 43 p Transl. into ENGLISH of a Paper Presented at the Symp. on Heat Exchange during Transients, Cadarache, France, 26–29 Apr. 1966
(ANL-TRANS-467; CONF-660455-1) CFSTI: HC $3.00/MF $0.65

Thermal phenomena occurring in a swimming-pool reactor channel as a result of fast power transients were investigated in out-of-pile experiments. Effects of a short power surge on hydraulic and thermal performance have been determined; the performance of instrumentation under these conditions has been evaluated. All measurements were made with natural convection, only. NSA

N67-36537# Argonne National Lab., Ill. Reactor Physics Div.
PHYSICS MEASUREMENTS IN TUNGSTEN-BASED, ALUMINUM-REFLECTED FAST REACTORS
R. C. Doerner, W. G. Knapp, K. K. Almenas, and R. A. Karam Mar. 1967 38 p refs
(Contract W-31-109-ENG-38)
(ANL-7007) CFSTI: HC$3.00/MF$0.65

The results of measurements made on four fast critical experiments performed in ZPR-9 summarized in support of the rocket-design effort. The fuel is highly enriched ^{235}U, the major diluent is a W–Re alloy, and the reflector material is Al. Data on cross section sets for W, Re, and ^{10}B are included. NSA

N67-36538# Max-Planck-Institut fur Metallforschung, Stuttgart (West Germany).
STUDIES ON THE HARDENING OF METALS DUE TO LOW TEMPERATURE REACTOR IRRADIATION [UNTERSUCHUNGEN ZUR BESTRAHLUNGSVERFESTIGUNG VON METALLEN NACH REAKTORBESTRAHLUNG BEI TIEFER TEMPERATUR]
J. Diehl, W. Decker, and Chr. Leitz Mar. 1967 37 p refs In GERMAN; ENGLISH summary
(BMWF-FBK-67-22)

The low temperature irradiation facility of the Karlsruhe Research Reactor FR-2, built for basic studies of the radiation damage of solids, is described. Special attention is paid to the possibilities of this facility for carrying out different types of experiments. A tensile testing machine developed for stress strain tests in the low temperature facility is described in detail. Measurements on the dose dependence of the critical shear stress of Al and Cu single crystals, carried out with this equipment, led to a better understanding of the origin of the irradiation hardening of these metals. Author (NSA)

N67-36541# United Kingdom Atomic Energy Authority, Risley (England). Reactor Group.
IN-PILE IRRADIATION EQUIPMENT AND TECHNIQUES
H. E. Tilbe, ed. 1967 123 p refs Presented at an Intern. Symp., Harwell (England), 10–12 May 1966
(TRG-1404(R)) HMSO: 15s

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N67-36542# United Kingdom Atomic Energy Authority, Risley (England). Reactor Group.
HIGH-TEMPERATURE BELLOWS-SEALED VALVES
W. P. White *In its* In-Pile Irradiation Equipment and Tech. 1967 p 3–8 ref (See N67-36541 21-22)

Summary information is presented on experiences with high temperature bellows-sealed valves used with liquid metals and gases. Aims and lines of development are discussed, and some valve designs are described. Author

N67-36543# United Kingdom Atomic Energy Authority, Risley (England). Reactor Group.
HIGH-TEMPERATURE BOLTED FLANGED JOINTS
W. P. White and N. A. C. Bromidge *In its* In-Pile Irradiation Equipment and Tech. 1967 p 9–32 refs (See N67-36541 21-22)

An extensive program was carried out to develop demountable bolted flanged joints to meet exacting requirements for leak tightness at high temperatures and high pressures. A type was developed, using a thin soft metal gasket which is compressed plastically between controlled-finish surfaces on the mating hubs. The design can be used in practically any environment when the right choice of materials is made, and it remains substantially leak tight at temperatures up to 600°C. The joint will withstand pressures significantly greater than the safe working pressures of the adjoining pipes, and its performance is not impaired by alternating applied bending moments or torsion of considerable magnitude. The results of exhaustive tests made on several sizes of joints are given. The leak rates of the joints tested were $\approx 10^{-9}$ atm/cm^3 sec per cm peripheral length of gasket, and were not measurably affected by changes of pressure. Author

N67-36544# United Kingdom Atomic Energy Authority, Risley (England). Reactor Group.
GAS BEARING CIRCULATOR
J. Dornan and E. Redstone *In its* In-Pile Irradiation Equipment and Tech. 1967 p 33–38 ref (See N67-36541 21-22)

Design information is presented on a totally enclosed gas bearing compressor for use at temperatures and pressures up to 300°C and 220 lb/in^2 abs. respectively. Experience gained from the operation of the machine is surveyed. Author

N67-36545# United Kingdom Atomic Energy Authority, Risley (England). Reactor Group.
HEATERS FOR IRRADIATION EXPERIMENTS. M. I. CABLES OVER 1.5 mm DIAMETER
A. Thomson and C. B. T. Braunton *In its* In-Pile Irradiation Equipment and Tech. 1967 p 39–42 (See N67-36541 21-22)

Heater cable diameters are discussed in relation to the methods employed in their use and the operational problems which may exist. Applications include the 3 kW coiled heater, the heater joint, the coil on former heater, and the coil on former heater with sprayed metal infill. A construction method is briefly described which was evolved to solve the problems that occur when the cable is used as the heating medium. The heating element is produced by swaging from commercial 3.0 mm (0.125 in.) diameter, metal-sheathed, magnesia insulated cable, with the diameter reduced by multiple swaging to minimum of 1.5 mm over the high temperature region. A length of cable at each end of the stock is maintained at the original diameter to provide connecting leads. Low-resistance connecting leads are formed at the exposed ends of the nickel–chromium conductors by brazing on copper wires and enclosing the exposed conductors in metal tubing insulated from the wire by preformed, crushable magnesia sleeves. The assembly is then compacted by swaging to form integral copper-cored mineral-insulated leads with an outside diameter of 3.75 mm. Their use in irradiation rigs is reported. M.G.J.

N67-36547# United Kingdom Atomic Energy Authority, Risley (England). Reactor Group.

USE OF CARBON DIOXIDE AT HIGH PRESSURES

N. Sheriff *In its* In-Pile Irradiation Equipment and Tech. 1967 p 49–50 ref (See N67-36541 21-22)

The dual role of carbon dioxide in providing the environment for the rig and the thermal insulation is considered in relation to the annular gap between the carrier and the inside of the pressure wall, and the problem of natural convection which reduces the insulating properties of the gap. A brief description is given of a method for reducing the natural convection in which the vertical annular gap was laterally subdivided by thin stainless steel shields. Experiments were carried out with several subdivisions, and typical results are depicted in which the effective conductivity is plotted against the square of the pressure. Results are also expressed in terms of the dimensionless parameters. It was concluded that the subdividing shields substantially improve the insulating properties of the annular gap, particularly at higher pressures. M.G.J.

N67-36548# United Kingdom Atomic Energy Authority, Risley (England). Reactor Group.

MAGNETIC FORMING

J. Denney *In its* In-Pile Irradiation Equipment and Tech. 1967 p 51–52 (See N67-36541 21-22)

An example is given of the use of novel techniques of manufacture and assembly to meet the special needs of some modern equipment for experimental irradiations. Author

N67-36549# United Kingdom Atomic Energy Authority, Risley (England). Reactor Group.

DEVELOPMENT OF TENSILE CREEP IRRADIATION EQUIPMENT

E. Catling and F. G. Wallace *In its* In-Pile Irradiation Equipment and Tech. 1967 p 53–60 refs (See N67-36541 21-22)

Investigations associated with the measurement of creep specimen expansion in-pile are discussed. The design and development of equipment for two series of experiments is described. Author

N67-36550# United Kingdom Atomic Energy Authority, Risley (England). Reactor Group.

DEVELOPMENT WORK IN SUPPORT OF THE D.M.T.R. BOILING WATER LOOP

H. Middlebrook and A. C. F. Bramfitt *In its* In-Pile Irradiation Equipment and Tech. 1967 p 61–68 (See N67-36541 21-22)

Development aspects are described of a small-scale pilot loop operated to support the design and manufacture of an in-pile boiling water loop for water chemistry and corrosion problems associated with a ferritic steel reactor system. Author

N67-36551# United Kingdom Atomic Energy Authority, Risley (England). Reactor Group.

OPERATING EXPERIENCE AND DEVELOPMENT ON WIGNER TYPE RIGS

J. D. Cuthbertson *In its* In-Pile Irradiation Equipment and Tech. 1967 p 69–74 (See N67-36541 21-22)

A brief description is presented on the type of rig commonly used for the irradiation of nonfissile materials. The kinds of operational faults experienced are outlined. The post-irradiation examination of failed rigs is reviewed, design weaknesses are noted, and subsequent improvements are described. Author

N67-36587# Battelle Memorial Inst., Columbus, Ohio. Columbus Labs.

POSTIRRADIATION EXAMINATION OF THE PM-3A TYPE 1 SERIAL 2 CORE. PART II: POSTIRRADIATION EXAMINATION OF CONTROL ROD 6

John B. Brown, Victor W. Storhok, and John E. Gates 28 Feb. 1967 42 p refs

(Contract NBy-63910)

(AD-654745)

Because of a Type 1 Serial 1 core control rod malfunction, one spent control rod from the PM-3A Type 1 Serial 2 core was examined in considerable detail. Measurements of blade configuration and dimensions showed no discernible changes except for increases in blade thickness. Blade Thickness measurements showed a 15-mil increase in blade thickness from top to bottom, suggesting that blade swelling was associated with increasing neutron dosage and probably operating temperatures. Examination of the blade microstructure showed that considerable longitudinal cracking had occurred in the Eu2O3-2TiO2- Type 304L stainless steel dispersion. These cracks were largest in the region adjacent to control rod weldments and appeared to propagate through stringers of dispersed europium titanate particles. Propagation of these cracks and possibly the formation of new cracks during reactor operation probably caused the observed increase in the thickness of the blade. Blade thickness increases were not sufficient to cause binding, as the rod moved freely in its clot. Although scale deposits were observed on the control rod, it is believed that such deposits would not interfere with control rod operation. Author (TAB)

N67-36589# Comitato Nazionale per l'Energia Nucleare, Rome (Italy).

DETERMINATION OF NEUTRON SPECTRA IN A COUPLED GRAPHITE-D_2O REACTOR [CONSIDERAZIONI SULL' ADATTAMENTO DEGLI SPETTRI NEUTRONICI IN UN REATTORE ACCOPPIATO GRAFITE-D_2O]

F. Casali 1966 18 p refs In ITALIAN

(RT/FI-(66)38)

The mismatching effect on k_∞ measurements is analyzed for some experiments concerning RB1 reactor loaded with ECO or CIRENE type fuel elements. The theoretical calculations, confirmed by some experimental results, show that the error on k_∞ due to spectral mismatching is of the order of 1% for these D_2O moderated lattices. Author (NSA)

N67-36594# Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material und Festkoerperforschung.

PHASE RELATIONS, PRODUCTION, AND CHARACTERISTICS OF SUBSTOICHIOMETRIC OXIDE FUELS (UO_{2-x} AND (UPu)O_{2-x}) [PHASENBEZIEHUNGEN, HERSTELLUNG UND EIGENSCHAFTEN VON UNTERSTOECHIOMETRISCHEM OXIDISCHEM KERNBRENNSTOFF (UO_{2-x} UND (UPu)O_{2-x})]

F. Thuemmler, R. Theisen, and E. Patrussi Feb. 1967 44 p refs In GERMAN

(KFK-543)

The concept of a substoichiometric oxide nuclear fuel material is discussed on the basis of the literature and specific results. The phase regions of UO_{2-x}, PuO_{2-x}, and (UPu)O_{2-x} are described. For the usual Pu content there does not exist, even at low temperatures, the danger of metallic U or Pu precipitation. In pure UO_2 this danger is present however. The problems of preparation appear technically soluble both for pellets and for vibration powder of (UPu)O_{2-x}. The compatibility with cladding materials was improved for single-phase (metal-free) substoichiometric products as shown by some examples with CeO_2 instead of PuO_2. The thermal conductivity increased at least up to 1,200 to 1,500°C. The improved thermal conductivity is of value in practical radiation research. Author (NSA)

N67-36595# Argonne National Lab., Ill.
HIGH CONVERSION CRITICAL EXPERIMENTS
A. R. Boynton, Q. L. Baird, K. E. Plumlee, W. C. Redman, W. R. Robinson et al Jan. 1967 81 p refs
(Contract W-31-109-ENG-38)
(ANL-7203) CFSTI: HC $3.00/MF $0.65

A program of critical experiments has extended the range of measured nuclear parameters of light-water-moderated, slightly enriched, UO_2 lattices further into the undermoderated region. The H-to-^{238}U atom ratios in the cores assembled ranged from about 5 to 0.5. The initial conversion ratio, ^{238}U-to-^{235}U fission ratio, ^{238}U capture Cd ratio, thermal disadvantage factor, and Cd ratios of various materials reported were measured in the full range of lattices; the bucklings, critical masses, and reflector savings reported were measured in the looser assemblies. Information on temperature coefficient and control-element and various material worths is included. Although the experimental results are not compared with calculations, these results are correlated with results obtained at other laboratories with similar fuel at higher H-to-^{238}U ratios. Author (NSA)

N67-36603# United Kingdom Atomic Energy Authority, Risley (England).
AXIAL STABILITY CALCULATIONS FOR A.G.R. SYSTEMS
B. Wilson, J. R. Enselmoz, and A. J. Hartley 1966 73 p refs
(TRG-1138(R))

Three methods of calculating axial stability modes in reactor systems are described: (1) modal analysis, (2) a steady state method using 'FLIRT', and (3) an analog method. In the modal analysis, criteria for an asymmetric flux, flattened flux, and sinusoidal flux are derived with one-term and three-term expansions for the harmonic. The steady state method yields a criterion for temperature instability which can accommodate any flux distribution and more accurate harmonic representation. The analog method is used to study and propose a performance criterion based on the transient performance of the harmonic. Stability thresholds and the relationship between the performance criterion and stability margins are obtained. This latter method of calculation is recommended, and the major conclusions resulting from the study are shown. C.T.C.

N67-36818# General Dynamics Corp., San Diego, Calif. General Atomic Div.
A PROGRAM OF BASIC RESEARCH ON MECHANICAL PROPERTIES OF REACTOR MATERIALS Quarterly Progress Report, Aug. 1–Oct. 31, 1966
T. A. Trozera and T. E. Firle 31 Jan. 1967 20 p refs
(Contract AT(04-3)-167)
(GA-7661) CFSTI: HC $3.00/MF $0.65

Progress of a research program on deformation mechanisms in high-purity bcc metals, caused by neutron irradiation, and in determining the nature of the forces resisting dislocation motion is reported. Details of sample preparation and mechanical-property measurements are given. NSA

N67-36819# Kernforschungszentrum, Karlsruhe (West Germany).
CONTAINMENT OF A LARGE SODIUM-COOLED FAST BREEDER REACTOR
K. Gast and W. Schikarski Feb. 1967 16 p refs
(EURFNR-289; KFK-647)

A practicable model for analysis of containment leakage, after excursion, is proposed for Na-cooled fast breeder reactors. A conceptual design study of a 300 MW(e) prototype is made to illustrate that use of double-containment precludes environmental hazard. NSA

N67-36638# Joint Publications Research Service, Washington, D. C.
USE OF RADIOISOTOPES AS POWER SOURCES
1 Sep. 1967 11 p Transl. into ENGLISH from Nucleus—Rev. Sci., La (Paris), v. VIII, no. 3, 1967 p 266–270
(JPRS-42391; TT-67-33020) CFSTI: HC $3.00/MF $0.65

The general characteristics of radioisotopic generators are described followed by a brief review of isotopic generators in service around the world. The use of isotopic generators to meet future European energy needs is discussed in terms of specific applications, economics, and security problems. The discussion points out that the reason why there are so few isotopic generators in Europe is due to the lack of isotopic production of an industrial scale. This in turn is probably due to the absence of a market, since potential users of isotopic generators are unaware of their technical and economic advantages. R.N.A.

N67-36648# Los Alamos Scientific Lab., N. Mex.
ULTRA HIGH TEMPERATURE REACTOR EXPERIMENT (UHTREX) FACILITY DESCRIPTION AND SAFETY ANALYSIS REPORT
Feb. 1967 541 p refs
(Contract W-7405-ENG-36)
(LA-3556 (Rev.)) CFSTI: HC $3.00/MF $0.65

Intended to advance the technology of gas cooled reactors, the Ultra High Temperature Reactor Experiment (UHTREX) is designed for the operation of a graphite-moderated, He-cooled reactor at a thermal power of 3 MW and a maximum gas temperature of 2400°F. The small graphite fuel elements containing enriched U operate in direct contact with the coolant and can be loaded or unloaded while the reactor is operating. The UHTREX facility design and operating plans are described. From analyses of postulated accidents and evaluation of safety features, it is concluded that the UHTREX facility can be safely operated. Author (NSA)

N67-36651# Los Alamos Scientific Lab., N. Mex.
DEVELOPMENT OF CALCULATIONAL METHODS FOR FAST REACTOR SAFETY ANALYSIS AT LASL
Carl A. Anderson, Jr. 24 Apr. 1967 22 p refs
(Contract W-7405-ENG-36)
(LA-3683) CFSTI: HC $3.00/MF $0.65

A method for computer analysis for a maximum credible accident for a fast reactor is presented. Safety problems, which are likely to be incurred in normal operation, are discussed. Methods of treatment of these are presented. Sample calculations of core characteristics are given. NSA

N67-36653# General Electric Co., Sunnyvale, Calif. Advanced Products Operation.
EXAMINATION AND EVALUATION OF RUPTURE IN EVESR SUPERHEAT FUEL ROD WITH 0.012-INCH THICK INCOLOY-800 CLADDING
S. A. Rabin, B. G. Atraz, M. B. Bader, H. J. Busboom, and V. E. Hazel Jan. 1967 72 p ref
(Contract AT(04-3)-189)
(GEAP-5416) CFSTI: HC $3.00/MF $0.65

Design, fabrication, and operation data for the Mark III EVESR nuclear superheat fuel are given. Post-irradiation inspection data on the prematurely failed wall-rod are presented. It is determined that the peak power rod had ruptured in the region of maximum power and cladding temperature. NSA

23 PHYSICS, GENERAL

Includes acoustics, cryogenics, mechanics, and optics. For astrophysics see: 30 Space Sciences. For geophysics and related information see also: 13 Geophysics; 20 Meteorology; and 29 Space Radiation.

N67-35378# Tulane Univ., New Orleans, La. Dept. of Mechanical Engineering.
A RESEARCH STUDY FOR A CONTINUUM THEORY FOR GRANULAR MEDIA Final Report
S. C. Cowin Jun. 1967 26 p refs
(Grant DA-ARO(D)-31-124-G559)
(AROD-4878-4-E; AD-654770)

The objective of this study was to establish a physically realistic continuum theory for granular media. Granular materials are considered here to be a two or three phase cohesionless system that is a mixture of solid granules whose diameters are in excess of 0.002 mm, air and/or water. The real materials that may be classified as granular are numerous, e.g. soil, sand, gravel, fresh concrete, bird shot, and seed grain. The primary concern with some of these materials is their behavior in flow, transport, and storage. For others the major interest is in their behavior under applied loading and self-weight, such as in slopes, fills, and foundations. A concern of current interest is lunar soil or dust whose behavior should be estimated before planning structures and transportation systems to be used on the moon. Author (TAB)

N67-35387# Oak Ridge National Lab., Tenn. Metals and Ceramics Div.
SOLUTIONS TO ELECTROMAGNETIC INDUCTION PROBLEMS
Caius Vernon Dodd (Ph.D. Thesis—Tenn. Univ., Knoxville) Jun. 1967 92 p refs
(Contract W-7405-ENG-26)
(ORNL-TM-1842) CFSTI: HC $3.00/MF $0.65

Methods of solving electromagnetic induction problems by use of the vector potential are discussed. The differential equations for the vector potential are derived from Maxwell's equations, and cylindrical symmetry is assumed. This differential equation is then solved by two different basic techniques: a closed form solution and a relaxation solution. For the closed form solution, sinusoidal driving currents and linear, isotropic, and homogeneous media are assumed. The differential equation is solved for two different conductor configurations: a rectangular cross-section coil above a plane with one conductor clad on another and a rectangular cross-section coil encircling a two conductor rod. The solutions for both configurations are given in terms of integrals of Bessel functions. The relaxation method is used for three different cases, the first being that for an applied current with a sinusoidal time dependence in a linear, isotropic, and inhomogeneous medium. The second case is a time sequential relaxation for an applied current with any type of time dependence in a linear, isotropic, and inhomogeneous medium. The third case is the same as the second, except the medium may be nonlinear. In the relaxation method finite difference approximations are made for all terms in the differential equation, and the vector potential at every point is expressed in terms of the vector potential at neighboring points. The vector potential at every point may be then solved using a relaxation (iteration) technique for any particular configuration of coil and material. Once the vector potential is determined, any physically observable electromagnetic phenomenon can be calculated from it. Equations are given for the eddy-current density, heating density, force density, induced voltages, and coil impedance for both perfect metals and metals with defects. Examples of the application of the relaxation technique to sove these problems and experimental verification of the answers are given. In most cases the agreement between calculated and measured values is good. These two techniques will allow the solution of a large number of electromagnetic induction problems. Author (NSA)

N67-35391# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
THE HIGH-FREQUENCY REGION OF THE SPECTRUM OF NOISE FORMATION OF A JET [VYSOKOCHASTOTNAYA OBLAST' SPEKTRA SHUMOOBRAZOVANIYA STRUI]
V. A. Krasil'nikov and R. E. Shikhlinskaya 23 Jan. 1967 20 p refs Transl. into ENGLISH from Univ. Vestn. Ser. III. Fiz. Astron. (Moscow), no. 3, 1964 p 72–81
(FTD-HT-66-380; TT-67-62272; AD-655012)

The spectrum and characteristics of the directivity of noise emitted by a submerged air jet flowing from a tapered nozzle at an excess pressure greater than the critical pressure (which is equal to 0.9 atm) are studied. The results of measuring the spectrum and the characteristics of directivity, which were compared with photographs of a jet in different operating conditions, allow one to consider that in the emission spectrum of a jet there is discrete emission connected with the cellular structure of the jet, high-frequency noise, which can be connected with vortical Mach waves, and comparatively low-frequency noise of turbulent origin. Author (TAB)

N67-35410# California Univ., Riverside.
THE ELECTRICAL PROPERTIES OF SEMIPERMEABLE MEMBRANES Final Report, 1 Jan. 1964–30 Jun. 1967
L. J. Bruner 30 Jun. 1967 49 p refs
(Contract Nonr-4443(00))
(AD-655137)

A brief summary is given of a research program on the electrical properties of semipermeable membranes. In addition, a full-length paper is appended: The electrical conductance of semipermeable membranes, part III, bipolar flow-symmetric electrolytes, by L. J. Bruner. (Parts I and II appeared in AD-609 316 and AD-625 470, respectively). This paper treats the case where permeant ions of both charge states are present. Numerical and approximate analytic results are presented. It is shown that, for this case a cube law should describe the voltage-current relationship in the high current limit. TAB

N67-35430# Princeton Univ., N. J. Dept. of Chemistry
RESEARCH ON DIELECTRIC PROPERTIES AND THE STRUCTURE OF MATTER Final Report, 1 Apr. 1956–30 Sep. 1966
Charles P. Smyth 20 Jun. 1967 15 p refs
(Contract Nonr-1858(09))
(AD-654206)

The measurement of the dielectric constants and losses of a large number of solids and liquids over a range of temperature and a very wide range of frequency is reported in a list of 45 papers. These measurements are used to draw conclusions as to molecular rotation in solids and to calculate molecular and intramolecular relaxation times, which give evidence as to molecular structures, inter- and intramolecular forces, hydrogen bonding, and resonance. Dielectric loss is found in pure, nonpolar liquids at millimeter wavelengths. Author (TAB)

N67-35549# Wayne State Univ., Detroit, Mich. Dept. of Chemistry.
ELECTRONIC COMPUTATIONS OF LIGHT SCATTERING FUNCTIONS FOR HETERODISPERSE SYSTEMS OF ISOTROPIC SPHERES
Mukul Yajnik, Jack Witeczek, and Wilfried Heller 6 Jul. 1967 20 p refs
(Contract Nonr-3511(00))
(TR-15(81); AD-654724)

Fortran programs were developed to compute light scattering functions for heterodisperse systems which can be described by a bi-parametric, unimodal, exponential distribution function. The program had to include the evaluation of the Mie functions for angular scattering for any arbitrary values of the size parameter alpha within the range $0 < \text{alpha} < 25$. This involves the generation of the Riccati-Bessel functions and Legendre polynomials. Two methods of numerical integration (viz. Gaussian Quadrature and

Simpsons rule) of the expressions containing the products of the Mie functions and the distribution function were investigated, and the results were compared. The theoretical results were also checked by extrapolation to the condition of monodispersity.
Author (TAB)

N67-35588# Johns Hopkins Univ., Baltimore, Md. Lab. of Astrophysics and Physical Meteorology.
DEVELOPMENT OF DIFFRACTION GRATINGS FOR THE FAR ULTRAVIOLET Final Scientific Report, 1 Apr. 1964–31 Mar. 1967
J. F. McClellan and John Strong 30 Apr. 1967 16 p refs
(Contract AF 19(628)-4077)
(AFCRL-67-0294; AD-655098)

Work on procedures of ruling gratings for the far ultraviolet is reported in the following areas: (1) Ruling tools other than diamond. (2) Improvements in tool shape and lubrication. (3) Ruling properties of glass surfaces—fire polish versus pitch and felt polish; and composition. (4) Resists and management of etching by ultrasonic agitation. (5) Etching by ion bombardment. (6) Interpretation of electron microphotographs of grating grooves.
Author (TAB)

N67-35706# Utah State Univ., Logan. Electro-Dynamics Labs.
SHAPE MEASUREMENT OF SMALL OPTICAL TARGETS Final Report, 1 Nov. 1963–31 Jan. 1967
D. J. Baker, C. K. Rushforth, M. C. Austin, and R. W. Harris 30 Apr. 1967 43 p refs
(Contract AF 19(628)-3825; ARPA Order 450)
(AFCRL-67-0289; AD-654275)

Techniques were developed to determine the shapes of optical objects from images corrupted by noise, diffraction and aberrations. Theoretical and experimental investigations were conducted using these techniques. The major part of the study has been reported in detail in several Scientific Reports but is reviewed here, along with the results of some preliminary and subsidiary work.
Author (TAB)

N67-35766# Michigan Univ., Ann Arbor. Dept. of Nuclear Engineering.
CAVITATION DAMAGE AND CORRELATIONS WITH MATERIAL AND FLUID
R. Garcia and F. G. Hammitt Sep. 1966 58 p refs
(Grant NSF G-22529)
(Rept.-05031-11-1)

A comprehensive set of cavitation damage data has been obtained in a vibratory facility using water, mercury, lithium, and lead-bismuth alloy as test fluids, and covering temperatures ranging from room temperature to 1500°F. Materials tested include a wide variety of metals and alloys. From this data a simple, reasonably precise, damage predicting equation has been derived, including only ultimate resilience as a material property, but also corrections for cavitation thermodynamic effects. It has been found that of the conventional mechanical properties, ultimate resilience is the most successful in this regard. A direct comparison between venturi and vibratory cavitation damage shows that the relative rankings of materials remains about the same for mercury, and a good correlation is obtained between the mercury data from the venturi and ultimate resilience. Neither statement applies for the water venturi data, possibly because of the greater effects of corrosion in the low intensity cavitation field.
Author

N67-35888*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
CHARGED PARTICLE ENERGIZATION BY AN ARBITRARILY MOVING MAGNET
T. J. Birmingham and T. G. Northrop Aug. 1967 15 p refs
(NASA-TM-X-55909; X-641-67-404) CFSTI: HC $3.00/MF $0.65
CSCL 20H

Second adiabatic theory is used to derive an asymptotic expression for the bounce-averaged rate of kinetic energy change $\langle \dot{W} \rangle$ experienced by charged particles trapped in electric and magnetic fields which conserve the first two invariants M and J of their motion. The restriction that there exist no electric field $E_{||}$ parallel to the magnetic field, reduces $\langle \dot{W} \rangle$ by one order in the idiabatic expansion parameter m/e from its $E_{||} \neq 0$ value. If in addition the magnetic field arises solely from, and convects rigidly with, the arbitrary motion of a perfectly conducting magnet, $\langle \dot{W} \rangle$ is smaller by yet another order in m/e. These results generalize and confirm the conclusions of Homes and Bergeson who consider $E_{||} = 0$ and the special case of a uniformly rotating conducting magnetized sphere with non-aligned rotation and magnetization axes.
Author

N67-35951# Technische Hochschule München (West Germany). Fakultaet für Maschinenwesen und Elektrotechnik.
INFLUENCE OF THE SUSPENSION FORCES AND SUPPORTING SPRING FORCES ON THE RUNNING BEHAVIOR OF FREE SETS OF STEERING WHEELS IN THE STRAIGHT TRACK. TEXT VOLUME (ACCOMPANYING PICTURE VOLUME) [EINFLUSS DER GEHAENGE- UND TRAGFEDERKRAEFTE AUF DAS LAUFVERHALTEN FREIER LENKRADSAETZE IM GERADEN GLEIS]
Gerd-Peter Bracker (Ph.D. Thesis) 1966 96 p In GERMAN
CFSTI: HC $3.00/MF $0.65

It is assumed that the two steering wheel sets underneath a railroad car run in a coordinated phase; thus, analysis of one half of the system can be extended to encompass the dynamics of the whole system by 4 second-order differential equations. These equations represent the following parameters: horizontal wheel transmission, wheel rotation around its vertical gravity axis, horizontal car transmission, and car rotation around its vertical gravity axis in the track direction. It is shown that the play between wheel and track is less than 2%, and that the rest of the differential equation value consists of nonlinearities represented by friction of springs and suspensions, as well as in bearing knock against the axle-box and the developing wheel flange.
Transl. by A.B.

N67-35954# Technische Hochschule Stuttgart (West Germany).
THE SIMULTANEOUS CALCULATION OF SPECIFIC VECTORS AND SPECIFIC VALUE SPECTRA OF ARBITRARY DYNAMIC MATRICES [DIE SIMULTANE BERECHNUNG VON EIGENVEKTOREN UND EIGENWERTSPEKTREN BELIEBIGER DYNAMISCHER MATRIZEN]
Peter C. Patton (Ph.D. Thesis) 1966 139 p refs In GERMAN

Discussed is a numerical solution for the eigenvalue problem that develops during matrix analysis on airfoil dynamics. The method rests on iteration of the Raleigh quotient with convergence quadrature. Example calculations are performed for bending and buckling phenomena, free oscillations, aeroelasticity, and orthogonal or almost orthogonal statics of aerodynamic power.
Transl. by G.G.

N67-36007# California Univ., Los Angeles. Dept. of Electrical Engineering.
RESEARCH IN OPTICAL COHERENCE Final Report
Robert S. MacMillan, Gregory O. Young, and James D. Arnett Dec. 1966 14 p refs
(Grant AF-AFOSR-188-66)
(USCEE-196; AD-654631)

The report summarizes the research in optical coherence and related subjects performed under Grant AF-AFOSR-188-66 during the past calendar year. It consists of a brief summary of the research performed during 1966 and a list of papers which have been published or which have been submitted for publication. During the past year, two papers have been published, and two papers have been submitted for publication.
Author (TAB)

N67-36009# Stanford Univ., Calif. Stanford Linear Accelerator Center.

SUPERCONDUCTING MAGNETS FOR HIGH ENERGY PHYSICS APPLICATIONS

H. Brechna Feb. 1967 44 p refs Presented at Intern. Cryogenic Eng. Conf., Kyoto

(Contract AT(04-3)-515)

(SLAC-PUB-274; CONF-670409-3) CFSTI: HC $3.00/MF $0.65

With the availability of high energy accelerators the need for powerful experimental, beam transport and special magnets is steadily increasing. Experimental high field large volume water-cooled or conventional magnets would have power requirements which would be economically unsound. Superconducting magnets have reached a stage where they can be incorporated in connection with high energy physics, and many laboratories are building experimental magnets to be used for charged particle energies between 10 and 20 GeV. Recent developments in hard superconductors, technological improvements and a better understanding of steady state stable behavior of superconducting magnets enables us to build multimegajoule energy magnets with fields approaching 100 kG in working values of several cubic meters. Recent trends in superconducting magnet design are discussed. A number of large superconducting magnets currently in operation are described as well as magnets in stages of procurement and planning. The use of ferromagnetic materials with superconducting magnets, the effects of superfluid and supercritical helium in magnet performance and forced liquid helium cooling are also treated. Author (NSA)

N67-36010# Stanford Univ., Calif. Stanford Linear Accelerator Center.

DETERMINATION OF THE QUALITY OF MULTIPOLE MAGNETS

J. K. Cobb, A. W. Burfine, and D. R. Jensen Jun. 1967 10 p Presented at 2d Intern. Conf. on Magnet Technol., Oxford

(Contract AT(04-3)-515)

(SLAC-PUB-313; CONF-670705-4) CFSTI: HC $3.00/MF $0.65

A large number of multipole magnets were analyzed and methods of final representation were developed that give in functional form $\int_{-\infty}^{+\infty}(\delta BdZ/B) = f(r,\theta)$ and $\int_{-\infty}^{+\infty}(\delta GdZ/G_0) = G(r,\theta)$ for the elements where $\delta B = B - G_0 r$ and G_0 is the gradient at the center. A computer program was written which uses as input data the directly read harmonic amplitudes at many discrete longitudinal positions and then computes the total integrated perturbation at various positions across the aperture.

Author (NSA)

N67-36114# Naval Research Lab., Washington, D. C.

TECHNIQUES FOR NUMERICALLY EVALUATING THE FORMULAS DESCRIBING MONOSTATIC REFLECTION OF ACOUSTIC WAVES BY ELASTIC SPHERES

Anthony J. Rudgers 7 Jun. 1967 63 p refs

(NRL-6551; AD-654385)

Numerical methods are described by which the theoretical formulas specifying the acoustic field resulting from scattering of an acoustic wave by an elastic sphere may be evaluated. They are restricted to the case of monostatic reflection of a plane harmonic wave incident upon the elastic sphere - the sphere being immersed in a uniform homogeneous fluid, the acoustic properties of which are assumed to be the same at all frequencies. Methods of calculating reflection form-functions as a function of sphere size-parameter are shown in the range of size-parameters $0 < ka$ less than 30.0. The reflection form-functions may be calculated at any distance from the elastic sphere by one of two formulas, one describing reflection in the far-field case. A description is given of the means by which the spherical Bessel function values, required in computations made using the reflection formulas, are calculated. Examples are given of form-function computational results in the case of reflection by elastic spheres and, for purposes of comparison, also in the case of reflection by rigid, immovable spheres. Brief tables of computed values of the far-field reflection form-function as a function of sphere size-parameter are given in the cases of an aluminum and of a rigid sphere. Implementation of the numerical methods described requires access to a digital computer. The capabilities and limitations of the two different computing machines used in the treatment of the elastic sphere problem by the numerical methods described, are discussed. Author (TAB)

N67-36165# ARO, Inc., Arnold Air Force Station, Tenn.

CRYOSORPTION OF HYDROGEN BY 12–20°K CARBON DIOXIDE CRYODEPOSITS Final Report, Sep.–Oct. 1966

R. Dawbarn Arnold Eng. Develop. Center, Jul. 1967 32 p refs

(Contract AF 40(600)-1200)

(AEDC-TR-67-125; AD-655067)

Carbon dioxide cryodeposits were investigated to determine their ability to SoRb H_2. Various thickness from 0.00005 to 0.001 cm were used. At temperatures of 12, 16, and 20K, pumping speeds of 28, 19, and 14 l/sec-sq. cm were measured for the respective temperatures. An arbitrary 'capacity' of the CO_2 cryodeposit for H_2 was defined. Within the limits of the experimental parameters varied, this capacity was found to be a direct function of the thickness of the cryodeposit and increased logarithmically as the temperature was lowered. No cryopumping of H_2 was observed with cryodeposits above 25K. The CO_2 cryodeposits were readily contaminated by N_2, and the H_2 pumping speed dropped when N_2 was flowed in simultaneously with the H_2. Author (TAB)

N67-36180* National Aeronautics and Space Administration, Washington, D. C.

FOUR-DIMENSIONAL HAMILTONIAN FORMALISM OF RAY TRACING IN AN ANISOTROPIC MEDIUM

L. G. Bossy Aug. 1967 11 p refs Transl. into ENGLISH of the book "Formalisme Hamiltonien Quadridimensionnel du Trace des Rayons dans un Milieu Anistrope" Heverle–Louvain, 1967 14 p

(NASA-TT-F-11188) CSCL 20N

Using the four-dimensional formalism of Poeverlein and of Suchy and Paul, a Hamiltonian form is established which permits generalization of the eikonal equation. The meaning of Haselgrove's equations is made more precise within the framework of Hamiltonian formalism. Eight canonical equations, reducing to seven if the medium is permanent, are integrated by a unique procedure, to facilitate a simultaneous determination of the trajectory of the beam and the transit time of the signal. Author

N67-36456# Advisory Group for Aerospace Research and Development, Paris (France).

COMPARISON OF RESULTS OF MEASURING THE TOTAL ELECTRON CONTENT OBTAINED BY THE FARADAY DIFFERENTIAL EFFECT AND BY THE COINCIDENCE METHOD [COMPARAISON DES RESULTATS DE LA MESURE DU CONTENU TOTAL D'ELECTRONS OBTENUS PAR LA METHODE DU FARADAY DIFFERENTIEL ET PAR LA METHODE DES COINCIDENCES]

F. Bertin and J. Papet-Lepine 1966 13 p In FRENCH; ENGLISH summary

(AGARD-552)

The calculation of total electron content by measurement of the Faraday differential effect requires the use of fairly small equipment for the recording of signals which are transmitted on two adjacent frequencies. Starting from the fundamental equation, it is easy to derive two methods of calculation, one using the coincidence between two Faraday zeroes produced on each frequency transmitted, the other based upon the angular deviation between

the Faraday effect on these two frequencies. The programming of all the digital calculations is described, and some results obtained by these two methods of calculations are compared. The mean difference does not exceed 5%. R.U.

N67-36461 Office National d'Etudes et de Recherches Aerospatiales, Paris (France).
ON THE CALCULATION OF THE MAXIMUM SOUND PRESSURE SPECTRUM FROM FIXED AND MOBILE JETS [SUR LE CALCUL DU SPECTRE DE PRESSION SONORE MAXIMALE EMIS PAR LES JETS STATIONNAIRES ET EN VOL]
Michel Kobrynski 1967 40 p refs In FRENCH; ENGLISH summary Presented at the Intern. Congr. on Aeron., Paris, 29–31 May 1967

The calculation of the maximum sound pressure spectrum from turbojets of airplanes on their take-off trajectory is based on the generalized expression of acoustical power emitted by the fixed or moving axisymmetric jets; it takes account of the laws of spatial distribution of the sound energy and of the generalized characteristics of the linear maximum sound pressure spectrum at a given distance of reference (30 m). The numerical solutions of the equation obtained are facilitated by the use of diagrams and necessitate knowing geometrical and aerodynamic parameters of the jets and also the airplane speed. Author

N67-36470 Kyoto Univ. (Japan). Dept. of Aeronautical Engineering.
CHARACTERISTICS OF ULTRASONIC PROPAGATION IN AIR
Maeda Hiroshi and Umeda Yoshikuni May 1967 17 p refs
(CP-12)

This report presents fundamental ultrasonic phenomena of propagation in air which are important to apply the ultrasonic techniques for detection, ranging and measurement in the atmospheric situation. The propagation loss or attenuation, directivity and wind effect are discussed. The propagation loss at high ultrasonic frequencies is so large that the experiments were made at 50kc and 75kc, and compared with the theoretical results. For the practical applications, the possible range of ultrasonic signaling in low frequencies were first investigated. The directivity which is important for improving the efficiency was next studied. Also, it was found that the wind effect was estimated by applying the directivity. Author

N67-36482# Maryland Univ., College Park. Dept. of Physics and Astronomy.
FIDCON
Gilbert Wolsky Apr. 1967 28 p refs
(Contract AT(40-1)-2504)
(ORO-2504-105; TR-676) CFSTI: HC $3.00/MF $0.65

A program (FIDCON) is described which is used to generate sets of optical parameters for use by the geometrical reconstruction programs such as PANG and TVGP. FIDCON is an outgrowth of 1–2–3 POP. Input to the program consists of measurements of fiducials and possibly of corresponding points. The corresponding points are treated as pseudo-fiducials. For each measurement two fits are attempted, an 8 parameter and a 10 parameters fit. Derivations are given for many of the equations used. The program, measuring procedure, and running instructions are described in detail. Results for the BNL 80" hydrogen bubble chamber are also given. Author (NSA)

N67-36560* Autonetics, Anaheim, Calif.
OPTICAL EFFECTS OF ATMOSPHERIC TURBULENCE
Mar. 1967 295 p refs Compilation of Results of Res. performed at the Electro-Opt. Lab., Autonetics, Torrance, Calif.
(Contract NAS8-18035)
(NASA-CR-88207; C7-805-401) CSCL 20F

A compilation is presented of research results and theoretical analyses of atmospheric effects on optical propagation. The subject matter included cover: infinite plane wave propagation in a randomly inhomogeneous medium; means, variances, and covariances for laser beam propagation through a random medium; spherical wave propagation in a turbulent medium; spectral and angular covariance of scintillation for propagation in a randomly inhomogeneous medium; diffusion analysis for the propagation of mutual coherence; statistics of a geometric representation of wavefront distortion; aperture averaging of scintillation; optical heterodyne detection of an atmospherically distorted signal wave front; atmospheric modulation noise in an optical heterodyne receiver; optical resolution through a randomly inhomogeneous medium for very long and very short exposures; limiting resolution looking down through the atmosphere; laser beam scintillation in the atmosphere; ground-to-space laser illuminator scintillation; atmospheric scintillation effect on an optical data channel; and Rytox approximation test. M.G.J.

N67-36569*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THE EFFECTS OF A SIMULATED PROTON SPACE ENVIRONMENT ON THE ULTRAVIOLET TRANSMITTANCE OF OPTICAL MATERIALS BETWEEN 3000Å AND 1050Å
Paul A. Sacher Aug. 1967 21 p
(NASA-TM-X-55911; X-622-67-416) CSCL 20F

Transmittances from 3000A–1050A of LiF, MgF_2, BaF_2, Al_2O_3, fused SiO_2, ADP, Calcite, and Vycor are given before and after irradiation by a total flux of 8.25×10^{10} protons/cm^2 evenly distributed over 3.0, 3.8, and 4.6 MeV. Author

N67-36604*# Southwest Center for Advanced Studies, Dallas, Tex.
ELECTROMAGNETIC SCATTERING FROM ABSORBING SPHERES
George W. Kattawar and Gilbert N. Plass 28 Dec. 1966 46 p refs Sponsored in part by NASA
(Contract AF 19(628)-5039)
(NASA-CR-88228; SR-1; AFCRL-67-0129; AD-649806) CFSTI: HC $3.00/MF $0.65 CSCL 20N

An efficient method for the calculation of Mie cross sections for absorbing particles is discussed. It is used to calculate an extensive set of curves which illustrate the dependence of the efficiency factors Q for absorption, scattering, and extinction on the size parameter x and on n1 and n2 (the real and imaginary parts of the index of refraction). Among the interesting features shown are the following: (1) as n2 increases, Q(sca) decreases to a minimum value before increasing, when $x > or = 1$ and for most values of n1; (2) the maximum value of Q(ext) at the first resonance decreases rapidly when a small amount of absorption is introduced; (3) over a considerable range of the parameters the width of the first resonance of Q(ext) is proportional to (n1) to the -4th power when there is no absorption and to (n2n1) to the -2nd power when there is absorption; (4) when $n1 > > 1$, the scattered intensity near the first resonance is predominately forward, symmetrical, or predominately backward when x is respectively somewhat smaller than, equal to, or larger than the resonance value; (5) as n2 increases, the forward scattered intensity first increases before it decreases, when $x > or = 1$ and for most values of n1; (6) the half-width of the angular intensity function varies as $1/x$ when $x > or = 10$ and is relatively insensitive to the value of n1 and n2. Author (TAB)

N67-36628# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy.
CRYOGENICS PROBLEMS CONNECTED WITH THE USE OF LARGE SUPERCONDUCTING SOLENOIDS [KRIOGENNYE PROBLEMY SVYAZANNYE S ISPOL'ZOVANIEM KRUPNYKH SVERKHPROVODYASHCHIKH SOLENOIDOV]

A. G. Zel'dovich, and Yu. A. Shishov 1967 19 p refs In RUSSIAN
(JINR-P8-3206)

The processes of cooling the stabilized superconducting solenoids are considered. The schemes of refrigerators, intended for the operation with large solenoids, are discussed. Necessary capacity of helium liquefier is estimated on the basis of calculations made for a 40 kG solenoid of the JINR 5-meter hydrogen chamber. A conclusion is drawn about the ability of modern cryogenic technique to solve the problems connected with the manufacturing and operation of refrigerators for large and heavy superconducting solenoids. Author (NSA)

N67-38646# Sandia Corp., Albuquerque, N. Mex.
LECTURES ON CONTINUUM MECHANICS
Ray M. Bowen (Louisiana State Univ., New Orleans) May 1967 308 p refs
(Contract AT(29-1)-789)
(SC-M-67-326) CFSTI: HC $3.00/MF $0.65

Lecture notes are presented in order to obtain an understanding of the basic axioms of continuum mechanics in a framework that is stripped of special constitutive equations and to obtain an understanding of nonlinear materials and their relationship to classical linearized theories. NSA

24 PHYSICS, ATOMIC, MOLECULAR, AND NUCLEAR

Includes atomic, molecular, and nuclear physics. For applications see: 22 Nuclear Engineering. For related information see also: 29 Space Radiation.

N67-35319 Laboratoire de Physique Theorique et des Hautes Energies, Orsay (France).
REMARKS ON CLASSICAL UNSTABLE PARTICLES AND THE LONG-RANGE SCALAR FIELD
J. Leite Lopes Rio de Janeiro, Centro Brasileiro de Pequisas Fisicas, 1967 14 p *Its* Notas de Fisica, Vol. XII, No. 19

A possible description of unstable particles, classically defined as those with a rest-mass depending on proper time, is examined. If one assumes the equality between inertial and gravitational masses valid for both stable and unstable particles, a universal interaction between a zero-mass scalar field and all particles, which would thus have a variable rest-mass, is allowed by this equality and has been proposed by Dicke in connection with Mach's principle. Author

N67-35320 Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro.
NUCLEAR INTERACTIONS PRODUCED IN THE EMULSION CHAMBER
M. Akashi, Z. Watanabe, J. Nishihura, K. Niu, T. Taira et al 1967 25 p refs *Its* Notas de Fisica, Vol. XII, no. 14

Large emulsion chamber (6 m^2 in area, 29 cm Pb thick) were exposed at Mt. Chacaltaya (5200 m) for about 10 months with a collaboration of Japanese and Brazilian emulsion groups. Several hundred γ rays incident upon the nuclear events produced in the chamber with energy higher than 2.10^{12} eV are observed and the results are reported. The results of observation at Mt. Norikura (2800 m) carried out by Japanese group are also included. Author

N67-35346* Wisconsin Univ., Madison. Theoretical Chemistry Inst.
ON THE ANALYTIC SOLUTION OF THE SCHROEDINGER EQUATION FOR THE TWO-ELECTRON ATOM
Ronald Joseph White 21 Aug. 1967 199 p refs
(Grant NsG-275-62)
(NASA-CR-88016; WIS-TCI-254) CSCL 20H

The technique, which may be called a partial series expansion method, consists of assuming a series form for the wavefunction in powers of the inter-electron separation with coefficients which are functions of two variables and of determining the coefficients so that a satisfactory solution of the Schrödinger equation results. The coefficients are related by first-order differential recursion relations which may be integrated explicitly. The method is not complete because the initial coefficient, independent of the inter-electron separation, is undetermined. The extension of the method to the hydrogen molecule and the two-electron atom in the presence of a uniform electric field is also considered. Two model atomic systems, the Hooke's law model and the delta-function model, for the two-electron atom are also discussed and it is shown that these systems, which are solvable through first order in a perturbation series, yield information about the difficulties which arise in the helium atom. Author

N67-35427# Instituto de Asuntos Nucleares, Bogota (Columbia).
EFFECTIVE CROSS SECTIONS FOR DEUTERON INDUCED REACTIONS IN RHODIUM [SECCIONES EFICACES PARA LAS REACCIONES INDUCIDAS POR DEUTERONES SOBRE RODIO]
I. de Betancourt and S. J. Nassiff Apr. 1966 14 p refs In SPANISH
(IAN-F-2)

The cross sections for the nuclear reactions $^{103}Rh(d,t)^{102}Rh$, $^{103}Rh(d,2p)^{103}Ru$, and $^{103}Rh(d,2n)^{103}Pd$ were determined experimentally. The deuteron energy in the incident beam was 27.5 MeV. The stack foil technique was used in order to reduce the energy down to the values corresponding to the threshold. Author (NSA)

N67-35432# Stanford Univ., Calif. High Energy Physics Lab.
DEAD-TIME CORRECTIONS FOR SLOW COUNTING SYSTEMS
Hall Crannell and Douglas Danforth Apr. 1967 13 p refs Submitted for publication
(Contract Nonr-225(67))
(HEPL-481; AD-654892)

The problems of correcting for counting-rate losses incurred by using detectors that can record only one event in the duration of the accelerator pulse are discussed. A method of accurately determining the dead-time losses in high counting rate situations, even when the beam intensity varies rapidly, is developed and experimental results are presented. Calculations of the statistical accuracy that can be achieved as a function of counting rate are shown. Author (TAB)

N67-35451# Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.
FISSION PRODUCT BEHAVIOR LITERATURE REVIEW
E. G. Good Feb. 1967 24 p refs
(Contract AT(10-1)-205)
(IDO-17237) CFSTI: HC $3.00/MF $0.65

A literature survey was made of the data available on fission product release, transport, and deposition. The report presents a bibliography of the literature which appears applicable to the development of analytical methods for calculating the fission product behavior following a loss-of-coolant accident involving a water-cooled, UO_2 fueled reactor. Experimental and theoretical work has been directed toward determining fission product behavior.

Much of this information, however, will be of little value in the development of analytical models for LOFT. The release data of fission product noble gases to the void space between the cladding and the fuel pellets during routine reactor operation are sufficient. The mechanism of fission gas release has not been definitely established but enough experimental results exist to provide an adequate basis for preliminary LOFT calculations. Additional data are needed concerning the release of fission products other than noble gases. Applicable data on fission product release from molten fuel and release during heatup to the fuel melting point are limited. Most of the work on transport and deposition in high-temperature gas streams has been directed toward the gas-cooled reactor program. Some of the theoretical work may be adaptable to the LOFT analysis. Once fission products enter the containment building they may undergo agglomeration, settling, diffusion, transport due to convection, absorption, desorption, and change in chemical form. The containment vessel experiments measure the combined results of several phenomena which occur simultaneously, thereby making interpretation of the results and extrapolation to other conditions difficult. Mathematical models will aid in separating the effects of different variables and allow extrapolation. Thus mathematical models must be developed and checked with additional experiments before extrapolation to LOFT conditions can be accomplished with any degree of certainty. NSA

N67-35526# Tokyo Univ. (Japan). Dept. of Physics.
FOUR BODY SEMILEPTONIC DECAY OF HYPERONS AND ALGEBRA OF CURRENTS
Syurei Iwao and Kimio Miura [1966] 16 p refs

The four-body semileptonic decay of hyperons was studied in the scheme of algebra of currents assuming the Cabibbo current, the partially conserved axial-vector current and the soft pion hypotheses. The S-matrix element may be approximated by the sum of the equal-time commutators of the relevant currents and single baryon terms. The $\Delta Y = \Delta Q$ rule between the initial and final hadrons admits nine electron associated decays. Three of them are highly forbidden in our approach, another three are associated with the induced neutral current and the rests are closely related to the three-body semileptonic decays. Finally, the relative rates of these decays are estimated numerically for use in experimental studies. Author

N67-35566# Illinois Univ., Urbana. Dept. of Physics.
NONLINEAR LEAST SQUARES COMPUTER ANALYSIS OF MOESSBAUER TRANSMISSION SPECTRA
Bruce L. Chrisman and Thomas A. Tumolillo May 1967 64 p ref
(Contract N00014-67-A-0305-0005)
(AD-654929)

It is known that computer programs which utilize blind search and maximum slope methods to fit a non-linear N-parameter function to experimental Mössbauer data are slow and unreliable, and if N is large, say $N > 10$ they cannot be used. The Hartley-modified Gauss-Newton method for fitting nonlinear functions by least squares and was applied to the fitting of Mössbauer data. Using this modified Gauss-Newton method, computer running time was reduced by roughly a factor of 20, and it was possible to fit functions with as many as 30 parameters in a few minutes. TAB

N67-35582# General Electric Co., Philadelphia, Pa. Missile and Space Div.
EFFECT OF EXPONENTIALLY DEPENDENT VIBRATION-TRANSLATION RATES ON STEADY STATE VIBRATIONAL DISTRIBUTIONS
Edward R. Fisher Jul. 1967 13 p refs
(R67SD36; AD-654776)

The effect of vibration-translation energy transfer rates which increase exponentially with vibrational level on non-Boltzmann vibrational distributions at steady state is investigated. Author (TAB)

N67-35590# Illinois Univ., Urbana. Dept. of Physics.
RELATION BETWEEN VECTOR AND AXIAL-VECTOR CABIBBO ANGLES IN BROKEN SU(3) SYMMETRY
N. F. Nasrallah [1966] 9 p refs
(Contract N00014-67-A-0305-0005)
(AD-654194)

The renormalization of the weak axial-vector coupling constant in the decay of a neutral Xi particle into a Sigma particle (superscript +) + a Beta particle, + a neutrino is calculated on the basis of the assumption that the SU(3) breaking is unimportant at high energies and the result used to show that the equality of the vector and axial-vector Cabibbo angles, which is expected to hold in the limit of exact SU(3) symmetry, is preserved by the symmetry breaking. Author (TAB)

N67-35648*# National Aeronautics and Space Administration, Washington, D. C.
TABLES OF MAXIMUM ENERGIES OF CHARACTERISTIC β-DECAY [TABELLE WICHTIGER β-MAXIMALENERGIEN]
V. Loessner Sep. 1967 35 p refs Transl. into ENGLISH from Staatliche Zentrale für Strahlenschutz (Berlin), Apr. 1968
(NASA-TT-F-11203) CFSTI: HC $3.00/MF $0.65 CSCL 20H

The maximum energies characteristic of beta decays are given for 120 isotopes arranged by order of energy. The table can be used in identifying unknown beta emitting isotopes if the maximum energy is measured. Author

N67-35664# Calif. Univ., Los Angeles. Dept. of Physics.
BETA AND GAMMA RAY STUDIES OF SHORT-LIVED ISOTOPES IN THE 2s-1d SHELL
Anthony J. Armini May 1967 110 p refs
(Contract Nonr-233(44))
(P-78; AD-654183)

The short lived beta and gamma spectra of Na20, Al24, P28, Cl32 and Sc40 have been measured with a single wedge gap magnetic spectrometer and a Lithium drifted Germanium detector. These isotopes were produced by proton induced reactions on the even-even $Tz = 0$ nuclei in the 2s-1d shell. Background and contaminants were separated from these short lived isotopes at each positron momentum by an on-line computer. The complete decay schemes are presented including the ground-state masses and the first $T = 1$ analog states in the daughter nuclei. These isotopes lie in an interesting transition region between the deformed (Na20 and Al24) and the spherical nuclei (Ca40). Author (TAB)

N67-35665*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.
DIFFERENTIAL CROSS SECTIONS FOR (D, α) REACTION ON SCANDIUM 45
Joseph R. Priest and John S. Vincent Washington, NASA, Sep. 1967 13 p refs
(NASA-TN-D-4140) CFSTI: HC $3.00/MF $0.65 CSCL 20H

The differential cross sections corresponding to the production of the ground and first five excited states of calcium 43 in the $Sc^{45}(d, \alpha)Ca^{43}$ reaction were measured for a deuteron energy of 20.9 MeV (33.5×10^{-13} J). The angular distribution for the ground-state transition extends from 15° to 170°; the remaining angular distributions range from 15° to 100°. The differential cross sections for the ground-state transitions are, in general, more than 10 times larger than those for the transitions to excited states; this is interpreted to be a consequence of the large overlap of the ground-state configurations of scandium 45 and calcium 43. The

differential cross sections for production of two core-excited states of Ca^{43} are small (1 to 10 μb/sr; 10^{-34} to 10^{-33} m^2/sr) but not negligible and are comparable to those of the other excited states investigated. The interpretation of the reaction mechanism for these transitions poses an interesting theoretical problem. Author

N67-35873# Nuklearni Institut Jozef Stefan, Ljubljana (Yugoslavia).
EXCITATIONS AS GROUND STATE VARIATIONAL PARAMETERS
M. V. Mihailovic and M. Rosina Mar. 1967 14 p Submitted for publication
(NIJS-R-498)

The ground state density matrix is expressed with transition amplitudes. A formalism is derived in which these transition amplitudes are used as ground state variational parameters. The quadratic form used imposes by itself a restriction on the two-body density matrix and this restriction is used as a substitute for the Pauli principle. The trial ground state is also restricted in such a way that already half of the particle-hole excited states exhaust the sum over $|r>$. The variational equations have the form of a secular equation similar to that in the random phase approximation. The single particle energies are, however, introduced as Lagrange multipliers for the trace relations of the density matrix. The one-body density matrix is also determined variationally. Additional Lagrange multipliers are introduced to guarantee certain symmetry relations, which are disregarded in the random phase approximation. The obtained ground state is consistent with excited states having different quantum numbers. The excited states are of the particle-hole type and are orthonormal. The method also works if the ground state is not quite near the Hartree–Fock ground state. Author

N67-35800# Zentralinstitut fuer Kernforschung, Rossendorf bei Dresden (East Germany).
SOME REMARKS ON THE SELECTION RULES FOR ELECTROMAGNETIC TRANSITIONS WITH SPIN-FLIP IN DEFORMED ODD–ODD NUCLEI [EINIGE BEMERKUNGEN ZU AUSWAHLREGELN FUER ELEKTROMAGNETISCHE UEBERGAENGE MIT SPIN-FLIP IN DEFORMIERTEN U–U–KERNEN]
Manfred Benitz, Alexander Andreeff, and Rudolf Kaestner Jan. 1967 15 p refs In GERMAN; ENGLISH summary
(ZFK-PHA-26)

It is shown that for spin–flip transitions in deformed odd–odd nuclei two different K-selection rules are possible. In the case in which the direction of the projection of the nuclear momentum on the nuclear symmetry axis is reversed in the transition, $|K_i + |K_f| \leq L$; otherwise $|K_f - K_i| \leq L$. The first selection rule leads in most practical cases to a high degree of forbiddeness. For instance, the high hindrance factor ($\approx 10^8$) of spin–flip El transitions, arising in the decay of the 4.1-μs isomeric state in ^{170}Tm, can be explained after the first rule by thrice K-forbiddeness. If the coupling schemes are well established, it is possible to predict the hindrance of transitions. Very high hindrance of transitions, on the other hand, seems to be related to coupling schemes involving the first selection rule. Author (NSA)

N67-35833# Deutsches Elektronen-Synchrotron, Hamburg (West Germany).
VALIDITY OF QUANTUM ELECTRODYNAMICS FOR WIDE-ANGLE ELECTRON PAIR PRODUCTION [GUELTIGKEIT DER QUANTENELEKTRODYNAMIK BEI WEITWINKEL-ELEKTRONENPAARERZEUGUNG]
Martin Rohde Apr. 1967 61 p refs In GERMAN; ENGLISH summary
(NP-16779)

An experiment on wide-angle electron pair production by the reaction $\gamma + C \rightarrow C + e^+ + e^-$ was performed to investigate the predictions of quantum electrodynamics at small distances. In contradiction to earlier experiments the result is consistent with theory up to an invariant mass M of the pair of 545 MeV/c^2, the best fit to the obtained ratio R of experimental to theoretical yield linear in M being $R = 0.95 \pm 0.04 - (0.4 \pm 1.1) \times 10^{-4}$ M. Author (NSA)

N67-35838# Brookhaven National Lab., Upton, N. Y. Bubble Chamber Group.
IONIZATION LOSS, RANGE, STRAGGLING, AND MULTIPLE SCATTERING
F. R. Huson [1966] 58 p refs
(BNL-11368) CFSTI: HC $3.00/MF $0.65

The various formulas and tables necessary for the geometry and kinematics programs for a mixture of H_2–Ne in a bubble chamber were calculated. The formulas were generalized so that they can be used for any molecular composition. In particular, formulas are given for dE/dx, range, straggling error, error from density, multiple scattering error, and radiation length. The Fortran program for calculating all these quantities for any given material is given. NSA

N67-35846# Atomic Energy Establishment, Winfrith (England). Control and Instrumentation Div.
A FISSION COUNTER FOR THE MEASUREMENT OF NEUTRON CAPTURE TO FISSION RATIO IN PLUTONIUM-239
F. H. Allen Mar. 1967 14 p refs
(AEEW-R-514)

By designing a fission counter with two electrode assemblies in one container it was possible to manufacture a counter containing 20 mg of ^{239}Pu. This required the use of a filling gas with a fast electron collection time, and a fast pulse channel amplifying system; a mixture of 85% argon and 15% methane at 100 lb/in.^{2} abs. was used. Good discrimination between alpha build-up pulses and fission pulses was achieved. Author (NSA)

N67-35851# Iowa State Univ. of Science and Technology, Ames.
CALCULATIONS OF DECAY CURVES FROM MASS DISTRIBUTIONS
Ann McDonald Nelson (M.S. Thesis) May 1967 75 p refs
(Contract W-7405-ENG-82)
(IS-T-166) CFSTI: HC $3.00/MF $0.65

A uniform treatment of stable and unstable particles in quantum field theory was presented by McEwan. A modification of this approach which leads to a considerable simplification in the formulas for an unstable particle wave packet described in terms of the particle's mass distribution (characterized generally by a mean mass and width) is discussed. Numerical calculations of decay curves are given for various mass distributions with the purposes of defining the range of validity of the exponential decay law and determining the effect of the mass distribution threshold. Author (NSA)

N67-35857# Eidgenoessiches Institut fuer Reaktorforschung, Wurenlingen (Switzerland).
LIE-PN, A PN-SPHERICAL HARMONICS, MULTI-GROUP, MULTI-REGION PROGRAMME
Ronald Alpiar Apr. 1967 42 p refs
(EIR-110)

A program is described which solves the time-independent neutron transport equation in a multi-region r-geometry reactor cell. The transport equation is broken down into sets of spherical harmonic equations (the P_n method), and the latter are solved for multi-group fluxes by the Lie method. Reflective outer boundary

conditions are applied, though the user may also feed in special boundary conditions in the form of a boundary-moment matrix. In homogeneous problems a very wide choice of eigenvalue parameters includes the possibility of simultaneously varying zone radii and material constants in the eigenvalue search. Source problems may also be fed in. The whole program is written in FORTRAN, all arrays being dynamically dimensioned and positioned in order to make most economical use of core storage: preparation of input data is on the "format-free" principle. Particular attention has been paid to making the program competitive in running time with similar codes. This report contains some basic theory and the mathematics of its application in the program-instructions for data preparation, description of program output, and tables of typical running times. Author (NSA)

N67-35858# Australian National Univ., Canberra. Research School of Physical Sciences.
COMPLEX ANGULAR MOMENTUM IN NUCLEAR REACTIONS
P. B. Treacy [1966] 20 p refs
(NP-16749)

The scattering amplitude and reaction line shapes in a spinless charged-particle channel, are analyzed in terms of poles in angular momentum. The case of $^4He+^4He$ is considered as an example of the one-pole approximation. Practical difficulties are considered in regard to lack of unitarity, wrong threshold behavior and ambiguity of background, and the representation. A modified representation is proposed, from which these difficulties are eliminated. Author (NSA)

N67-35859# Eidgenoessiches Institut fuer Reaktorforschung, Wurenlingen (Switzerland).
ANALYTICAL SOLUTION OF THE ENERGY-DEPENDENT NEUTRON TRANSPORT EQUATIONS IN THE S_N FORMULATION [ZUR ANALYTISCHEN LOESUNG DER ENERGIEABHAENGIGEN NEUTRONEN-TRANSPORT-GLEICHUNG IN S_N FORMULIERUNG]
H. Beuchat Nov. 1966 94 p refs In GERMAN
(EIR-98)

An attempt was made to find an analytical solution of the S_N differential equation for the case of a cylindrical symmetrical arrangement (the case of a plain arrangement is contained in this arrangement as a special case). The following problems were treated extensively: explicit solution of the S_N differential equation in vacuum, solution of the S_N differential equation by Lie series at a development stage $r_0=0$, solution of the S_4 differential equations at the singular development place $r_0=0$ with special series, solution of the S_4 differential equations at the site $r_0=0$ using the Lie series, convergent detection of the solution of the latter two, solution of the S_N differential equation at the singular development site $r_0=0$ using a special series recursion, and detailed statement of the preceding in the solution of a concrete boundary value problem. The basic studies were carried through to permit the complete analytical solution of the S_N differential equation. These analytical solutions have with respect to the usual S_N solutions the advantage of accuracy which can be assumed independent of the calculation method. The analytical solutions are so developed that in the case of long convergents or in the case of numerical instability the possibility of analytical continuation is given. A generalization of the analytical method to multidimensional problems appears possible. Author (NSA)

N67-35881# Deutsches Elektronen-Synchrotron, Hamburg (West Germany).
T-INVARIANCE AND COMPTON SCATTERING OF PROTONS [T-VERLETZUNG UND COMPTONSTREUUNG AM PROTON]
Barbara Otto Mar. 1967 66 p refs In GERMAN; ENGLISH summary
(DESY-67/8)

The requirement of T invariance reduces the number of independent scattering amplitudes of P invariant proton Compton scattering from eight to six and correspondingly the number of independent polarization coefficients from 64 to 36. The 64 polarization coefficients are calculated in terms of the eight scattering amplitudes. The relations between them resulting from the T-invariance requirement are given in terms of general analytic expressions. These relations offer possibilities of experimentally testing T invariance by intensity or polarization measurement. In almost all of the tests, two scattering experiments are compared. They have identical kinematics, but in the second experiment the imposed polarizations of the primary particles must be exchanged for the measured polarization components of the secondary particles with respect to the first experiment (i.e., the polarization conditions are time reversed). It is shown how experimental tests can be simplified considerably in a well-known manner at energies below the meson π production threshold in the e^2-approximation of the scattering amplitude. Author (NSA)

N67-35895 Laboratoire de Physique Theorique et des Hautes Energies, Orsay (France).
ALGEBRA OF CURRENT AND THE DEVIATION FROM THE $|\Delta I| = 1/2$ RULE IN $K \rightarrow 3\pi$ DECAY
C. Bouchiat and Ph. Meyer Jul. 1967 9 p refs
(TH/207)

Starting from the usual current–current weak Lagrangian and using current algebra, the deviations from the $|\Delta I| = 1/2$ rule in $K \rightarrow 3\pi$ decays are determined in terms of the $K \rightarrow 2\pi$ rates. The need for better data on $K \rightarrow 2\pi$ and $K \rightarrow 3\pi$ decays is stressed in order to arrive at a possible discrimination between a fundamental or a dynamic $|\Delta I| = 1/2$ rule. As a by-product the PC conserving 3π decay of K_1^0 is calculated in the linear approximation. Author

N67-35907# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics.
STATIC QUADRUPOLE MOMENTS OF SPHERICAL EVEN-EVEN NUCLEI
E. B. Bal'butsev and R. V. Dzholos 1967 15 p refs Submitted for publication
(JINR-E4-3286)

The anharmonic corrections to the approximate second quantization method are obtained. The static quadrupole moments of ^{98}Ru, ^{100}Ru, ^{102}Ru, ^{104}Pd, ^{106}Pd, ^{108}Pd, ^{110}Pd, ^{110}Cd, ^{112}Cd, ^{114}Cd, ^{116}Cd, ^{122}Te, ^{124}Te, ^{126}Te, ^{128}Te, and ^{130}Te are calculated. Author (NSA)

N67-35908# Joint Inst. for Nuclear Research, Dubna (USSR).
BUILDUP OF CHARGED RADIATION COMPONENT IN THE SHIELDING [NAKOPLENIE V ZASHCHITE ZARYAZHENNOGO KOMPONENTA IZLUCHENII]
B. S. Sychev 1967 6 p refs In RUSSIAN Submitted for publication
(JINR-P9-3269)

Solution of an equation of charged particle transport in the semi-infinite space is presented. The main assumptions, in writing the equation, are the neglect of the secondary cascade processes under the action of charged particles and of the Coulomb scattering. The way obtained to solve this equation allows one to calculate, comparatively easy, the distribution function of the charged particle flux density, when the source density distribution is given. Author (NSA)

N67-35909# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems.

THE CAPTURE OF STOPPED π^--MESONS IN THE MIXTURE OF ^{3}He AND NITROGEN [ZAKHVAT OSTANOVIVSHIKHSYA π^--MEZONOV V SMESI GELIYA-3 I ZOTA]

V. I. Petrukhin, Yu. D. Prokoshkin, and A. I. Filippov 1967 6 p refs In RUSSIAN Submitted for publication

(JINR-P1-3255)

The yields of π^0 mesons, produced by the stopping of π^- mesons in the mixture of helium-3 and nitrogen, are measured. It is shown that the capture of π^- mesons by helium-3 and nitrogen atoms is proportional to the stopping power of atoms. Author (NSA)

N67-35935# Istituo Superiore di Sanita, Rome (Italy). Laboratori di Fisica.

MEASUREMENT OF THE ANGULAR DISTRIBUTIONS OF PROTONS EXTRACTED FROM ^{12}C BY HIGH ENERGY ELECTRONS [MISURA DELLE DISTRIBUZIONI ANGOLARI DEI PROTONI ESTRATTI DAL ^{12}C CON ELETTRONI DI ALTA ENERGIA]

U. Maldi, Jr., G. Campos Venuti, G. Cortellessa, E. De Sanctis, S. Frullani et al 12 Sep. 1966 17 p refs

(ISS-66/30)

The angular distributions of protons extracted by 600 MeV electrons from the 1s and 1p shells of ^{12}C were measured and the results analyzed in terms of two simple nuclear potential wells. Author

N67-35955# Tokyo Univ. (Japan). Inst. of Space and Aeronautical Science.

SLOW-ELECTRON SCATTERING BY STRONGLY POLAR MOLECULES

Yukikazu Itikawa May 1967 14 p refs

(ISAS-412, Vol. 32, No. 5) CFSTI: HC $3.00/MF $0.65

The cross section for electron scattering by a polar molecule is calculated taking account of temporary capture of the electron in the dipole field of the molecule. The calculation is based on the second-order time-dependent perturbation theory in which a temporary captured state is to be regarded as an intermediate one. If the dipole moment D of the molecule is relatively large (the numerical example is given for $D=2.50\times10^{-18}$ esu cm), the scattering cross section is enhanced due to the process of electron capture. Author

N67-35985*# Wisconsin Univ., Madison. Theoretical Chemistry Inst.

EXCHANGE EFFECTS IN THE DEGENERATE PERTURBATION THEORY OF INTERMOLECULAR POTENTIALS

David A. Micha 31 Jul. 1967 25 p refs

(Grant NsG-275-62)

(NASA-CR-88189; WIS-TCI-244) CFSTI: HC $3.00/MF $0.65 CSCL 20H

The contribution of electron exchange to intermolecular potentials is studied using the operator form of perturbation theory, when the non-interacting system of atoms or molecules is degenerate. A general, symmetry adapted degenerate perturbation theory is developed, including the almost-degeneracy case. Perturbation expansions are given up to second order in the energy. Differential equations for the perturbed wavefunctions are obtained, as well as their associated variational principles. Author

N67-35994# Eidgenoessiches Institut fuer Reaktorforschung, Wurenlingen (Switzerland).

P_N-THEORY IN r-θ-GEOMETRY

T. Auerbach and J. Mennig Apr. 1967 54 p refs Supplement to TM-PH-180(2)

(EIR-115)

Kofink's method of solving the transport equation in P_N approximation was extended to r-θ geometry. It is shown how the treatment may be applied to multigroup theory. Two types of interface boundary conditions are discussed. Since the method is primarily intended for use with heterogeneous theory, no cell boundary is defined. Instead, there is a condition on the asymptotic behavior of the scalar flux. Numerical results are given for monopole and dipole extrapolation lengths at the surface of a natural uranium rod immersed in D_2O. Author (NSA)

N67-36023# Akademiya Nauk URSR, Kiev. Institut Teoreticheskoi Fiziki.

ON EXISTENCE OF A SOLUTION OF THE BETHE-SALPETER EQUATION IN A CASE OF LEPTON INTERACTIONS. [PART] I

V. A. Jatsun 1967 37 p refs Submitted for publication

(ITF-67-4)

The solution of the integral equation for the trace of the scattering amplitude for lepton scattering via the vector meson interaction is considered. The analytical properties of the solution regarded as a function of the parameter g^2 are studied. NSA

N67-36036*# Avco-Everett Research Lab., Everett, Mass.

COMPUTER EXPERIMENTS ON LOW DENSITY CROSSED-FIELD ELECTRON BEAMS

R. H. Levy and R. W. Hockney Jun. 1967 32 p refs Submitted for publication

(Contracts NAS8-20310; AF 49(638)-1553)

(NASA-CR-88133; Avco-Everett Res. Rept.-273) CFSTI: HC $3.00/MF $0.65 CSCL 20H

The motions of thin and thick low density ($q-\omega_p^2/\omega_c^2 << 1$) crossed-field electron beams have been studied on the computer. Theoretical indications that such beams can be stable or unstable depending on the geometrical and electrical arrangements are supported, and the large amplitude behavior of a typical unstable configuration is found. In particular, thick, re-entrant beams can be quite stable against perturbations of the diocotron type. Author

N67-36039* Wisconsin Univ., Madison. Theoretical Chemistry Inst.

AN APPLICATION OF HIRSCHFELDER–SILBEY PERTURBATION THEORY TO THE H_2^+ ION: A CRITICISM OF AND CORRECTION TO WIS–TCI–180

Paul A. Westhaus 8 Mar. 1967 9 p refs (See N66-37904)

(Grant NsG-275-62)

(NASA-CR-86791; WIS-TCI-227) CSCL 20H

An error occurring in WIS-TCI-180 by Hake, Silbey, and Hirschfelder in which the Hirschfelder–Silbey perturbation technique is applied through first order to the lowest gerade and ungerade states of the H_2^+ ion is reported. The calculations were performed once again with the following ideas included. Results are listed at the end of this report and indicate that the disparity in agreement between our values of $E_g(1)$ and $E_u(1)$ with the corresponding exact values of Peek is roughly the same for the gerade as for the ungerade state. Previously it was reported that the ungerade energy was in very good agreement while the corresponding gerade energy was relatively poor. It might now be said that agreement of $E_g(1)$ and $E_u(1)$ with the values of Peek is fair for both states. The essential idea to be pointed out here is that once the basis functions on nucleus a have been chosen the corresponding states on nucleus b are uniquely specified by the action of the reflection operator σ. Author

N67-36049# Kernforschungszentrum, Karlsruhe (West Germany). Zyklotron-Lab.

INVESTIGATION OF DEUTERON-BREAK-UP NEUTRONS BY A TIME-OF-FLIGHT METHOD AT 50 MeV [UNTERSUCHUNG VON DEUTERON-BREAK-UP NEUTRONEN MIT EINER FLUGZEITMETHODE BEI 50 MeV]

G. W. Schweimer Oct. 1966 54 p refs In GERMAN
(KFK-504)

In the irradiation of targets (Be, C, Al, Fe, Co, Ni, Cu, Nb, Mo, Pb, Ag, Ta, Pt, and Au) with 50-MeV deuterons, a broad neutron spectrum with a maximum intensity at about 25 MeV arises. This neutron spectrum is principally formed of deuteron breakup neutrons. For the theoretical description of the neutron spectrum, a potential (optical nuclear potential and Coulomb potential) dependent only on A and Z was introduced. The shell structure of the target nucleus obtained in the neutron spectra in the area at the half deuteron energy is not remarkable. In the light nuclei ($Z<24$) the nuclear potential contributes principally to the breakup and for heavy nuclei ($Z>24$) the contribution of the Coulomb potential is preponderant. Author (NSA)

N67-36066# California Univ., Berkeley. Lawrence Radiation Lab.

INTENSITY BEATS IN RESONANCE RADIATION AND ABSORPTION DUE TO COHERENT EXCITATION OF ATOMS BY ELECTRON IMPACT

Tetsuo Hadeishi 13 Mar. 1967 9 p refs Presented at the 27th Ann. Conf. on Phys. Electronics, Cambridge, Mass., 20–22 Mar. 1967
(Contract W-7405-ENG-48)
(UCRL-17445; CONF-670320-2) CFSTI: HC $3.00/MF $0.65

Intensity beats were observed in the resonance luminescence arising from the interference of electromagnetic-field quanta that are emitted from the coherently excited nondegenerate magnetic sublevels of the excited state of atoms formed by sharply pulsed, low-energy, unidirectional electron beams. In a metastable state, a similar effect was obtained by monitoring the beats in the resonance absorption. Since a large concentration of the coherently excited metastable states is required in the absorption experiment, a space-charge neutralized, high-flux unidirectional, low-energy, high-frequency modulated electron beam was used. These experiments were performed (1) to find out if the phenomena are observable and (2) to offer new methods of investigation of excited atoms. Author (NSA)

N67-36068# Groningen Rijksuniversiteit (Netherlands).

SPECTRUM SHAPES OF FIRST FORBIDDEN BETA TRANSITIONS

Henricus Beekhuis (Ph.D. Thesis) 1967 117 p refs
(NP-16764)

Shape measurements were made of first-forbidden beta transitions in the nuclei ^{24}Na, ^{141}Ce, ^{142}Pr, ^{147}Nd, ^{166}Ho, ^{198}Au, and ^{199}Au using a magnetic lens spectrometer, consisting of a cylindrical vacuum chamber with diaphragms, around which current carrying coils and an iron yoke are placed. Beta particles emitted from the source are transmitted through the diaphragms and are focused on the detector. At each spectrometer current, only beta particles in a narrow energy range reach the detector. The counting rate of the detector, measured as a function of spectrometer current, yields the required energy distribution of the beta particles. Methods for optimizing and testing the instrument for precise shape measurements are treated. The theory of first forbidden beta decay is also discussed. S.F.L.

N67-36085 Grumman Aircraft Engineering Corp., Bethpage, N. Y. Research Dept.

BORN CROSS-SECTIONS FOR SINGLE-TRANSITION COLLISIONS OF TWO HYDROGEN ATOMS

Frank R. Pomilla Jul. 1967 51 p refs
(RE-296J)

Inelastic collisions of two hydrogen atoms are studied in which only one of the atoms makes the jump to a higher quantum level and the other remains in the ground state. Born cross sections are calculated for the reactions $H(1s) + H(n\ell) \rightarrow H(1s) + H(n'\ell')$, where $n \leq 7$, $\Delta n \geq 1$, and Δl takes on all possible values. The results are tabulated for the total-level cross sections for $(n \rightarrow n')$ transitions, calculated from the cross sections for the $(n\ell \rightarrow n'\ell')$ transitions by taking the appropriate averages over ℓ and summations over ℓ'. The results indicate that for incident energies less than 10 keV, the Born cross sections for all the single-transition collisions studied are larger than those for corresponding double-transition collisions. Author

N67-36091# Zentral Institut fuer Kernforschung, Rossendorf bei Dresden (East Germany).

CALCULATION OF THE LEVEL SCHEME OF V^{52} BY THE SHELL MODEL [RECHNUNGEN ZUM NIVEAUSCHEMA VON V^{52} IM SCHALENMODELL]

Hans Ulrich Gersch, Claus Riedel, and Werner Rudolph Jan. 1967 36 p refs In GERMAN; ENGLISH summary
(ZFK-PHA-25)

Based on the assumption that the low-lying states of ^{52}V can be described by three protons in the $f_{7/2}$ shell and one neutron in the $p_{3/2}$, $p_{1/2}$, and $f_{5/2}$ shells, the excitation energies and the corresponding eigenfunctions were calculated. For the matrix elements of the proton–neutron interaction, the potential of an exchange force with a Gaussian radial shape was used. The range and the strength of this potential as well as the exchange character of the proton–neutron force were treated as free parameters. On the other hand, the matrix elements of the proton–proton interaction were determined using the level scheme of the neighboring nucleus ^{51}V. The single-particle energies are also taken from experimental data. The results of the shell-model calculation are sufficiently good for a not very sharp region in the parameter space. They give a fairly good agreement not only with the experimental level scheme, but also with the spectroscopic factors for the $^{51}V(d,p)^{52}V$ reaction, the branching ratios for M1 transitions, and the lifetime of a recently found 5^+ isomeric state. Author (NSA)

N67-36094# Giessen Univ. (West Germany). Erstes Physikalisches Institut und Strahlenzentrum.

BACKSCATTERING OF β-PARTICLES FROM LITHIUM-ION-DRIFT SILICON DETECTORS [RUECKSTREUUNG VON β-STRAHLEN AN SILIZIUM P-I-N HALBLEITERZAEHLERN]

E. A. Huehn Mar. 1967 27 p refs In GERMAN; ENGLISH summary
(BMWF-FBK-67-18)

The response of Li-drifted Si detectors to monoenergetic β-particles from 200 to 1700 keV is studied. The low energy tail and the energy loss factor are determined from the measured spectra. The energy loss factor, varying from 17% at 200 keV to 40% at 1.7 MeV, is a linear function of primary β-particle energy. Besides the backscattering, another effect contributing to the low energy tail is possibly caused by ionization processes in the Si wafer of the counter. This effect becomes dominating with increasing β energy. The results are applied to correct the ^{204}Tl Curie plot. NSA

N67-36095# Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany).

HIGH ENERGY PHYSICS INDEX, VOLUME 5, NO. 4(1269–1956)

1967 244 p refs
(AED-C-23-12)

The high energy physics index contains experimental physics including general reactions, weak, electromagnetic, and strong

interactions, strange particles, accelerators, methods and instruments, and general experiments. Theoretical physics is also covered including general, weak, electromagnetic, and strong interactions, strange particles, symmetry principles, and field theory. Author, report number, and subject indexes are given. NSA

N67-36097# Chicago Univ., Ill. Dept. of Physics.
AN ANALYSIS ON DATA ON DOUBLE TRANSITIONS IN He
David P. Chock and U. Fano [1966] 17 p refs
(Contract AT(11-1)-1674; ARPA Order SB-89)
(COO-1674-2) CFSTI: HC$3.00/MF$0.65

A summary and comparison of information from various experimental and theoretical sources on the probability of double electron jumps in helium are given. Data from photon and particle bombardments were analyzed. NSA

N67-36139# Comitato Nazionale per l'Energie Nucleare, Rome (Italy).
VOLUMETRIC FRACTION MEASUREMENT OF VAPOR BY γ OR X-RAY ATTENUATION METHOD [MISURA DELLA FRAZIONE VOLUMETRICA DI VAPORE COL METODO DELL'ATTENUAZIONE γ O X]
W. J. Baran and P. Lupoli 1966 142 p refs In ITALIAN
(RT/ING-(66)10)

A general method for calculating energy and activity of a γ-source for void fraction measurement by the attenuation method is described. The results obtained for test-sections of different shapes and dimensions are discussed. Besides a detailed analysis of a scintillation counter for detecting γ-rays of low energy is made. Author (NSA)

N67-36146# Akademiya Nauk URSR, Kiev. Institut Teoreticheskoi Fiziki.
ON SUMMATION OF CONTRIBUTIONS FROM THE FEYNMAN DIAGRAMS, AN EXISTENCE THEOREM, I
D. Ya. Petrina 1967 39 p refs Submitted for publication
(ITF-67-3)

An attempt is made to sum up the contributions from the Feynman diagrams for the model of a neutral scalar field with the interaction Lagrangian $g\phi^3(x)$. NSA

N67-36174 Laboratoire de Physique Theorique et des Hautes Energies, Orsay (France).
PHENOMENOLOGICAL ANALYSIS OF K→3π DECAY
M. Gourdin Jul. 1967 63 p refs
(TH/208) CFSTI: HC$3.00/MF$0.65

A phenomenological analysis is made of the K→3π decay assuming a discrete symmetry like TCP or time reversal and possible PC violations. A particular attention is paid to the $|\Delta I| = 1/2$ rule and we define a four parameter representation of the spectra corresponding to a second order approximation of the amplitudes with respect to a convenient phase-space parameter. Author

N67-36188* Volt Technical Corp., Washington, D. C.
UNIVERSAL FORMULA FOR THE MASS IONIZATION COEFFICIENTS ι/ρ OF X- AND γ-RAYS. STUDY OF THE CONTINUOUS "TECHNICAL" SPECTRUM
H. Tellez-Plascencia 28 Aug. 1967 6 p refs Transl. into ENGLISH J. Phys. Radium (Paris), suppl. no. 3, v. 17, Mar. 1956
(Contract NAS5-12487)
(NASA-CR-88281; ST-SPR-10641) CSCL 20H

A formula is proposed, which is easy to derive, for the coefficient ι/ρ defining the energy of electrons liberated by the absorption of X- and γ-rays. Author

N67-36196# Deutsches Elektronen-Synchrotron, Hamburg (West Germany).
SUM RULES IN PERTURBATION THEORY
G. Kramer and K. Meetz Apr. 1967 24 p refs
(DESY-67/11)

Sum rules derived from isospin current algebra are examined in perturbation theory for nucleons interacting with neutral pseudo-scalar mesons and isovector pions. It is shown that the well-known sum rules for electromagnetic isovector form factors of nucleons and pions are correct in zero and second order of the meson-nucleon coupling constant. Author (NSA)

N67-36197# Deutsches Elektronen-Synchrotron, Hamburg (West Germany).
DEPENDENCE OF STORAGE RING LUMINOSITY ON THE REGION WIDTH AND ON THE CROSSING ANGLE [ABHAENGIG KEIT DER SPEICHER-RING-LUMINOSITAET VON DER TAILLENWEITE UND VOM KREUZUNGSWINKEL]
A. Piwinski Mar. 1967 24 p refs In GERMAN
(DESY-67/7)

The storage ring luminosity as limited by the beam–beam space charge interaction is calculated, taking into account the crossing angle, the shape of the amplitude function in a low-β-region, and the dependence of the Q-shift on the position of the particle within the bunch. It appears that there is an optimum value β_0 for which the luminosity has a maximum. With increasing crossing angle and given beam size, the Q-shift falls off more rapidly than the luminosity. By adjusting the beam cross section for constant Q-shift, an increase of luminosity with increasing crossing angle is obtained. Author (NSA)

N67-36198# Hamburg Univ. (West Germany).
MEASUREMENT OF THE BEAM CURRENT IN THE 6-GeV ELECTRON SYNCHROTRON DESY UTILIZING THE SYNCHROTRON RADIATION
R. Haensel and B. Sonntag Mar. 1967 7 p refs
(DESY-67/9)

An optical method, based upon a measurement of the intensity of the synchrotron radiation given off by electrons, for determining the beam current in the 6-GeV electron synchrotron DESY is presented. NSA

N67-36200# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems.
NOTE ON THE SUM RULES FOR THE COMPTON-EFFECT AMPLITUDES [ZAMECHANIYA O PRAVILAKH SUMM DLYA AMPLITUD KOMPTON-EFFEKTA]
L. I. Lapidus 1967 9 p refs In RUSSIAN
(JINR-P2-3301)

Sum rules resulting from dispersion relations without subtracting for spin-dependent amplitudes of the nucleon Compton effect at $Q^2 = 0$ are considered. The determinations of the invariant amplitudes and the amplitudes in the center of mass system are given. NSA

N67-36234# Bureau International des Poids et Mesures, Sevres (France).
REPORT ON THE INTERNATIONAL COMPARISON OF MEASUREMENT OF THE EMISSION RATE OF THE CONSEIL NATIONAL DE RECHERCHES NO. 200-1 Ra–Be NEUTRON SOURCE [RAPPORT SUR LA COMPARAISON INTERNATIONALE DER LA MESURE DU TAUX D'EMISSION DE LA SOURCE DE NEUTRONS Ra–Be (α,N) DU CONSEIL NATIONAL DE RECHERCHES NO. 200-1 PAR LA METHODE DE RALENTISSEMENT DES NEUTRONS DANS UNE SOLUTION DE SULFATE DE MANGANESE]
V. Naggiar 27 Feb. 1967 50 p refs In FRENCH
(NP-16703)

A comparative analysis is given of the measurements of the emission rates of the No. 200-1 Ra–Be neutron source made between Jan. 1962 and March 1965 by various laboratories. The methods used by the various laboratories are outlined, and the corrections necessary for each method are given. The errors in each method are determined. The results are shown in tables and by graphs. (NSA)

N67-36237# California Univ., Berkeley. Lawrence Radiation Lab.

A MEASUREMENT OF THE DIFFERENTIAL CROSS SECTIONS FOR CHARGE EXCHANGE AND RADIATIVE CAPTURE OF NEGATIVE PIONS IN HYDROGEN AT 50 MeV LABORATORY ENERGY

Jim B. Carroll (Ph.D. Thesis) Apr. 1967 62 p refs
(Contract W-7405-ENG-48)
(UCRL-11697) CFSTI: HC $3.00/MF $0.65

The differential cross sections of $\pi^- + p \rightarrow \gamma + n$ and $\pi^- + p \rightarrow \pi^0 + n$ ($\rightarrow\gamma+\gamma+n$) were measured at an incident pion laboratory-system kinetic energy of 54 MeV. The reactions were identified by detecting and measuring the energy of a final-state photon with a large total absorption counter placed at a laboratory-system angle of 84 deg. Analysis of the photon energy spectrum yields the center-of-mass differential cross section for the first reaction, $d\sigma_1/d\Omega^*$ (θ^*=90 deg) deg) = 51.5±10.7 μb/sr, and the coefficients of the Legendre expansion of the center-of-mass system differential cross section for the second reaction, $d\sigma_2(\theta^*)/d\Omega^* = \Sigma_{i=0}^{2} A_i P_i$ (cos θ^*), where A_0 = 0.68±0.04 mb/sr, A_2=0.53±0.09 mb/sr, and A_1 is not determined. Using the principle of detailed balance, and the measurement of the cross section for the first reaction, the isotropic term in the cross section for the reaction $\gamma+n\rightarrow\pi^-+p$ were calculated, and the results obtaining a_0=15.4±3.2 μb/sr at p_γ^*=170 MeV/c were obtained. This value is in reasonable agreement with other data obtained from photoproduction in deuterium. Author (NSA)

N67-36288# Atomics International, Canoga Park, Calif.

COMPARISON OF BERYLLIUM PHOTONEUTRON DECAY SETS USING EXPERIMENTAL SNAP REACTOR DATA

E. H. Ottewitte 22 Feb. 1967 6 p refs
(Contract AT(11-1)-GEN-8)
(NAA-SR-Memo-12347) CFSTI: HC $3.00/MF $0.65

The Rotter core set was found to be particularly advantageous over the conventionally used Keepin set by tests using SNAP reactor data. Author (NSA)

N67-36290# Instituto de Investigacion Aeronautica y Espacial, Buenos Aires (Argentina).

PHENOMENOLOGICAL ANALYSIS OF ROTATIONAL STATES IN DEFORMED EVEN-EVEN NUCLEI

S. M. Abecasis, H. E. Bosch, and C. A. Heras Dec. 1966 10 p refs
(Grant DA-ARO-49-092-66-G121)
(NP-16668)

A comparison of the rotation–vibration and the asymmetric rotor (with vibrations) models with recent experimental data on some rare-earth nuclei is made. For the three lowest rotational bands, good agreement with experiment is obtained. The approximate equivalence between the two models is corroborated. The consistency with calculations based on microscopic theories is also achieved. Author (NSA)

N67-36398# Akademiya Nauk URSR, Kiev. Institut Teoreticheskoi Fiziki.

RECENT PROGRESS IN MESON AND BARYON SPECTROSCOPY

A. Rosenfeld 1966 37 p refs
(ITF-66-3)

Previous data on resonance production from polarized proton interactions are displayed in the form of Argand diagrams, and the characteristic behavior of resonances is reviewed. Resonances as Argand circles, Argand diagrams for π+p scattering, states with spin 7/2, other new states and Regge recurrences are covered. The discussion of mesons includes isospin-0, −1 mesons and the Deck effect, and isospin-1/2 mesons (κ). NSA

N67-36400# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics.

ON THE FIELD THEORY WITH INFINITE MULTIPLETS IN THE SU(2,2) SYMMETRY [K TEORII POLYA S BESKONECHNYM MUL'TIPLETOM V SIMMETRII SU(2,2)]

Cao Chi 1967 15 p refs In RUSSIAN Submitted for publication
(JINR-P2-3200)

Two series of degenerate unitary representations of the group SU(2,2) (the principal and the supplementary ones) were found previously. The reduction $SU(2,2)\supset|SU(2)\otimes SU(2)\otimes U(1)|_p$ where p is the four-momentum of particles and the classification of particles according to the irreducible representations of the maximal compact subgroup were also given. The vertex of the interaction of an infinite multiplet with a singlet field is considered. The expression of a "unique propagator" of an infinite boson and fermion multiplet is given. The true propagator of a particle with definite spin can be obtained from the "unique propagator" with the help of projection operators. Besides it is shown by using the "unique projection" that in many cases the field theory with infinite multiplets leads to convergent diagrams while they are divergent in the conventional field theory. Author

N67-36404# Princeton Univ., N. J.

APPROXIMATION FOR ELECTRONIC ENERGY LOSS BY FISSION FRAGMENTS

Pablo Mulas (Inst. Politec. Nacl.) and Robert C. Axtmann [1966] 4 p refs Presented at the 13th Ann. Am. Nucl. Soc. Meeting, San Diego, Calif.
(Contract AT(30-1)-2807)
(NYO-2807-29; CONF-670802-3) CFSTI: HC $3.00/MF $0.65

The energy-distance relation $E/E_0=(1-x/R_e)^2$ for fission-fragment energy loss where electronic stopping is predominant is investigated. In this equation E is the average energy of fragments of initial energy E_0 which has penetrated a distance x, and R_e is an electronic range which has appropriate limits. Predictions of the equation are compared with experimental data on ^{235}U fission fragments in the gases H_2, He, air, carbon dioxide, Ne, and Ar. NSA

N67-36418 Tokyo Univ. (Japan). Dept. of Physics.

MODEL TREATMENT OF DILUTE He^3 SOLUTION IN LIQUID He^4

Tsuneo Nagata, Toshio Soda, and Katsuro Sawada [1967] 14 p refs
(TUEP-67-16)

Elementary excitations of the synthesized system of a dilute He^3 solution in liquid He^4 are calculated. The model Hamiltonian is used, which expresses the energies of the fermion and boson systems as the collection of energies of the boson type elementary excitations like phonon, roton zero sound and pair excitations. The stability of the synthesized system is discussed by finding the nonimaginary value of the energy. The condition for phase seperation is derived. As an application the thermal conductivity of the He^3–He^4 system is computed for very low temperature, approximating the synthesized excitation as composed of phonon and particle-hole excitations. The conductivity is expressed in terms of the phonon part and the He^3 part, with modifications due to the He^3 concentration. Author

N67-36463# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems.

LITHIUM-8 PRODUCTION IN CAPTURE OF SLOW NEGATIVE PIONS BY CARBON, NITROGEN, AND OXYGEN NUCLEI [OBRAZOVANIE LITIYA-8 PRI ZAKHVATE MEDLENNYKH π-MEZONOV YADRAMI UGLERODA AZOTA I KISLORODA]

Yu. A. Batusov, S. A. Bunyatov, V. M. Sidorov, and V. A. Yarba 1967 16 p refs In RUSSIAN
(JINR-PI-3305)

With the help of photoemulsions, two- and three-particle reactions with the production of ^{8}Li and ^{8}B nuclei in the negative pion capture by carbon, nitrogen, and oxygen nuclei were investigated. The relative probabilities w_i of two-particle decays of light nuclei are found to be smaller than 2.10×10^{-16}. The probability of the reaction $\pi^- + {}^{12}C \rightarrow {}^{8}Li + {}^{3}He + n$ is obtained to be 2.2×10^{-4}. The reactor $\pi^- + {}^{16}O \rightarrow {}^{8}Li + {}^{7}Be + n$ is strongly suppressed. The energy spectra and angular correlations of secondary particles for the reaction $\pi^- + {}^{12}C \rightarrow {}^{8}Li + {}^{3}He + n$ are measured. Experimental data indicate the important role, in negative pion capture by light nuclei of the mechanism of a direct capture of small-nucleon associations in nuclei, which agrees with the theory of direct nuclear reactions. Author (NSA)

N67-36458# California Univ., Berkeley. Lawrence Radiation Lab.

NEW ACCELERATORS FOR VERY HEAVY IONS: PRODUCTION OF SUPER-ELEMENTS

Albert Ghiorso Mar. 1967 15 p refs Presented at the Particle Accelerator Conf., Washington, D. C., 1–3 Mar. 1967
(Contract W-7405-ENG-48)
(UCRL-17295; CONF-670307-49) CFSTI: HC $3.00/MF $0.65

A general picture is presented on the production of the super elements Z>101 and the requirements imposed on accelerators designed to further this research. NSA

N67-36493# Controls for Radiation, Inc., Cambridge, Mass.

A SURVEY OF METHODS FOR MEASUREMENTS OF RADIATION FIELDS FROM THE AFCRL LINEAR ACCELERATOR

Victor Ozair May 1967 68 p refs
(Contract AF 19(628)-5980)
(AFCRL-67-0301; SR-2; AD-654690)

The survey of methods for radiation monitoring is presented. It includes detailed explanation of various approaches for appropriate dosimetry of flux, energy spectra and dose rates of intense pulsed gamma rays and neutrons. Emphasis has been given on those methods which are better suited for measurements of pulsating mixed fields from the AFCRL linear accelerator. Instrumental methods of detection using gas detectors, scintillators and solid state crystals are described. The following methods: thermoluminescent and exoelectron dosimetry, photographic emulsions activation foils, threshold detectors and self powered detectors are also surveyed. These methods are compared for applications around the linear accelerator. As of now, it appears that thermoluminescent dosimetry is well suited for dose measurement of gamma radiation while photoneutron threshold reactions and photographic films can be applied for measurements of the gamma spectrum. Neutron measurements of flux and energy spectrum are best accomplished by activation foils and threshold detectors. Though these methods are not capable of very good precision, they have the important advantage of excellent discrimination against gamma radiation from a pulsating accelerator output. Thermoluminescent detectors, LiF types 6 and 7, can be applied to the measurement of thermal and fast fluxes as these phosphors are useful to differentiate neutrons in mixed fields. Author (TAB)

N67-36506# General Dynamics Corp., San Diego, Calif. General Atomic Div.

DIFFERENTIAL NEUTRON THERMALIZATION Annual Summary Report, 1 Oct. 1965–30 Sep. 1966

W. L. Whittemore 10 Feb. 1967 63 p refs
(Contract AT(04-3)-167)
(GA-7439) CFSTI: HC $3.00/MF $0.65

A general atomic neutron velocity selector was used to study the details of neutron scattering in liquid parahydrogen, liquid D_2O, and reactor-grade graphite. The scattering into various angular directions between 30 and 150° was studied for incident neutrons with energies ranging up to ≈0.7 eV. The energy-transfer cross sections were evaluated for the larger values of incident energy to provide data in a region not readily accessible to experimenters, using a reactor as a source of neutrons. For the cases of D_2O and graphite, the data are also presented in terms of the scattering law. These provide information for much larger values of energy exchange (β up to 10 and above) than previous work, from which the largest values of β were in the order of 2. The cross-section data are compared in detail with theoretical results, where these are available. Author (NSA)

N67-36509# Brookhaven National Lab., Upton, N. Y. Accelerator Dept.

SUPERPERIOD GRADIENT PERTURBATIONS IN THE AGS

J. C. Herrera and M. Month 24 Apr. 1967 38 p refs
(BNL-11423; AGSCD-15) CFSTI: HC $3.00/MF $0.65

The theory of gradient perturbations in the AGS is applied to various superperiod distributions of quadrupoles. The following arrangements were specifically analyzed: the two quadrupoles presently used in the AGS at injection field, a group of four quadrupoles capable of correcting the β function distortion existing at injection field, and a distribution of ten quadrupoles designed to produce a shift in the ν value with a uniform change in the β function. The first order perturbation theory is also applied to an idealized AGS. NSA

N67-36513# Aarhus Univ. (Denmark). Matematisk Institut.

SCHROEDINGER EQUATION FOR QUANTUM FIELDS WITH NONLINEAR NONLOCAL SCATTERING

James Glimm Jan. 1966 47 p refs
(Grant NSF GP-4364)
(NP-16735)

Hamiltonian operators of the form $H = H_0 + V$ are considered where H_0 is the Hamiltonian for a free field and V is a polynomial in the creation annihilation operators. The Lie algebra formed by such Hamiltonian operators is studied, and the Schroedinger equation for these Hamiltonian operators is solved. Extensive use of topology is made in defining the V operators and their domains and in the solution of the Schroedinger equation. NSA

N67-36525# Brookhaven National Lab., Upton, N. Y.

LEVEL STRUCTURE OF Os^{190}

M. A. Mariscotti, W. R. Kane, and G. T. Emery (Indiana Univ., Bloomington) 25 May 1967 15 p refs Presented at the Meeting of the Am. Phys. Soc., Washington, D. C., Apr. 1967 Sponsored in Part by ONR and AEC
(BNL-11426; CONF-670414-2) CFSTI: HC $3.00/MF $0.65

The energy levels of ^{190}Os were studied using thermal neutron capture by ^{189}Os. High- and low-energy spectra were obtained using Ge(Li) detectors and a Ge–NaI combination for two-dimensional coincidence experiments. Gamma intensities were determined together with level parities, positions, and spins. A level scheme is proposed. NSA

N67-36588# Deutsches Elektronen-Synchrotron, Hamburg (West Germany).

BEAM PROFILE MEASUREMENTS WITH SILVER PHOSPHATE GLASSES [STRAHLPROFILMESSUNG MIT SILBERPHOSPHATGLAESERN]

V. Eckardt Apr. 1967 21 p refs In GERMAN
(DESY-67/12)

After irradiation with X-ray, γ-ray, or particle beams silver phosphate glasses show photoluminescence when subsequently exposed to ultraviolet light. The intensity of the emitted red light is linearly proportional to the beam intensity over several decades. For measuring beam profiles 8×3 cm plates of 0.2 cm thickness were used. A semi-automatic apparatus for evaluating the intensity distribution in the glass plates is described. Beam profiles were measured over 4 decades of intensity with only a few percent of error. Examples of profiles and iso-intensity curves are presented. The same method was applied to the determination of shower development in lead at 2.84 GeV. The data show good agreement with theoretical predictions. Author (NSA)

N67-36570# Aktiebolaget Atomenergi, Stockholm (Sweden).

ABSOLUTE El, $\delta K=0$ TRANSITION RATES IN DD-MASS Pm AND Eu-ISOTOPES

Sven G. Malmskog Jul. 1967 34 p refs
(AE-287) CFSTI: HC $3.00/MF $0.65

The half life of the $5/2^-(532)$ intrinsic state in ^{151}Pm, ^{153}Eu and ^{155}Eu has been determined by the delayed coincidence method. The absolute El, $\Delta K=0$ transition probabilities between the $5/2^-(532) \rightarrow 5/2^+(413)$ intrinsic states have been deduced and compared with theoretical predictions, using the Nilsson model as a starting point. The effect on the predicted transition probabilities obtained by adding pairing correlations and Coriolis coupling have also been studied. It has been found that the experimental transition rates, which are still strongly enhanced, cannot be explained by these contributions alone. It is therefore suggested that collective dipole contributions like those arising through the octupole excitations are of importance. Author

N67-36599# California Univ., Berkeley. Lawrence Radiation Lab.

BOUNDS FOR THE CORRECTION TO THE BORN TERM AND APPLICATIONS TO P-P SCATTERING FOR A GENERALIZED DISPERSION MODEL

Judith Binstock (Ph.D. Thesis) 3 May 1967 41 p refs
(Contract W-7405-ENG-48)
(UCRL-17571) CFSTI: HC $3.00/MF $0.65

A generalized dispersion model for the unitarizing correction to the Born term is given. (Only equal-mass, elastic scattering is considered.) The upper and lower bounds on this correction are explicity given, in terms of the experimentally available direct-channel phase shifts. This model is shown to include as special cases the Chew–Arndt, MacGregor–Arndt (j_0 even), Scotti–Wong, and Kantor models. The main features of the model are analyticity (except for cuts from unitarity and crossing), specifications both of the number of fluctuations of the left-hand-discontinuity (LHD) of the correction term and of the asymptotic behavior of the correction term, and unitarity of the full partial-wave amplitude. A similar exploitation of the analyticity and unitarity of the full partial-wave amplitude is shown to yield a consistency condition relating the number of fluctuations of the LHD of the full partial-wave amplitude to the direct-channel phase shifts. Author (NSA)

N67-36620# California Univ., Berkeley. Lawrence Radiation Lab.

A REVIEW OF THE PHYSICAL CHARACTERISTICS OF PION BEAMS

Mudundi R. Raju, Chaim Richman, and Stanley B. Curtis 17 Mar. 1967 27 p refs Presented at the 1st Intern. Symp. on the Biol. Interpretation of Dose from Accelerator-Produced Radiation, Berkeley, Calif., 13–16 Mar. 1967
(Contract W-7405-ENG-48)
(UCRL-17441; CONF-670305-4) CFSTI: HC $3.00/MF $0.65

Experimental bases for the use of negative pions in radiotherapy are reviewed. Following pion capture by tissues, the pion cascades down the atomic levels to the ground state of the atom in a time that is short compared with its lifetime. The relative frequency with which different elements capture pions is closely proportional to their relative abundance by mass. Energy partition for negative pion capture in water is calculated for a pion beam containing muon and electron contaminants. Negative pions are produced in the reaction of the proton beam with the neutrons in the Be nucleus. Intensity of the negative pion beam at the 184-inch synchrocyclotron at Berkeley is 5 rads/hr for a beam size of ≈7 cm by 7 cm. The beam has a contamination of 25% electrons and 10% muons, and the beam intensity is two orders of magnitude lower than that needed for therapeutic application. It is concluded that negative pion beams may be applicable in radiotherapy. NSA

N67-36622# Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research.

THE FISSION OF ^{197}Au BY 13.4-MeV DEUTERONS

L. Natanson and P. Decowski 1967 7 p refs
(INR-772/I/IA/PL)

The method of fragment detection in mica was used for the investigation of the reaction $^{197}Au(d,f)$ with 13.4-MeV deuterons. The number of fragments observed corresponded within experimental errors to the expected effect of U contaminstion of the Au sample which was tested in a separate experiment with reactor neutrons. The upper limit of the Au fission cross section is estimated to be 10^{-34} cm^2. Author (NSA)

N67-36624# Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research.

RECENT DEVELOPMENTS IN THE THEORY OF NUCLEAR MATTER

Janusz Dabrowski 1967 30 p refs Presented at the 17th Ann. Conf. of Nucl. Spectry. and Nucl. Struct., Kharkov, 1967
(INR-778/VII/PL)

Since the successful nuclear matter calculation of Brueckner and Gammel in 1958 the situation of the theory for some time became less satisfactory for two reasons. First, calculations with the more up-to-date nuclear forces produced a value of the binding energy per nucleon, $-E/A$, smaller than the empirical value. Second, a careful treatment of the single-particle potential energies of excited states, initiated by Bethe, produced a further reduction in $-E/A$. The second difficulty has been resolved by Bethe, who included into the theory all the three-body diagrams. The series of these diagrams can be summed by an integral equation due to Faddeev. The single-particle potential energies are thereby reduced essentially to zero, and $-E/A$ is increased correspondingly. Thus only the first difficulty remains which, however, can be overcome by applying nuclear forces with a "soft" repulsive core. Recent calculations of $-E/A$ brings its value again into agreement with the experiment. Author (NSA)

N67-36625# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics.

EXTENSION OF $SU(6)_w$ TO NONCOLLINEAR PROCESSES

V. I. Ogievetskii and I. V. Poluborinov 1967 35 p refs
(JINR-E2-3279)

A relativistic symmetry group $SU(6)_w$ is proposed. It is isomorphic to SU(6), leaves the conventional free equations of motion invariant and is compatible with the crossing symmetry. The 35- and 56-plets are discussed and a rule for writing invariant amplitudes is given. The $SU(6)_x$ symmetry turns into the $SU(6)_w$ one for collinear configuratons. Author (NSA)

N67-38627# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics.
MODEL OF QUANTUM FIELD THEORY WITHOUT ULTRAVIOLET DIVERGENCES [MODEL'KVANTOVOI TEORII POLYA BEZ UL'TRAFIOLETOVYKH RASKHODIMOSTEL]
M. K. Volkov 1967 8 p refs In RUSSIAN Submitted for publication
(JINR-P2-3270)

The previously constructed four-dimensional unitary relativistic model of quantum field theory without ultraviolet divergences is generalized in the case of the nonzero rest masses of spinor particles. Previously the rest masses of all the particles were assumed equal to 0. Author (NSA)

N67-38630# Tennessee Univ., Knoxville.
STUDY OF THE REACTION BETWEEN DEUTERIUM ATOMS AND BROMINE MOLECULES USING CROSSED MOLECULAR BEAMS
Thomas William Schmidt (Ph. D. Thesis) Mar. 1967 79 p refs
(TID-23837) CFSTI: HC $3.00/MF $0.65

The angular distribution of deuterium bromide product molecules form the reaction $D+Br_2 \rightarrow DBr+Br$. The possibility that the product was formed by wall reactions was considered. In the reaction at least 0.1% of the DBr produced is internally excited by an amount that equals 99% of the total available energy. Given the laws of classical mechanics and the angular distribution of the products and the reaction collision yield, estimation of the effects of impact parameters on the distribution of internal energy in the products were made. NSA

N67-38641# Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research.
EMISSION OF FAST DEUTERONS IN VERY LARGE STARS INDUCED BY 9-GeV PROTONS IN NUCLEAR EMULSION
Pelagia Ciok, Marta Soltan, and Krzysztof Soltynski 1967 18 p refs
(INR-775/VI/PH)

Emission of deuterons of momenta from 520 MeV/c to 720 MeV/c in 102 very large stars ($N_h \geq 28$, N_h-number of heavily ionizing particles per star) in nuclear emulsion was investigated. The stars belonged to the extreme class of interactions of the 9-GeV protons with heavy nuclei in emulsion (predominantly Ag) corresponding to large energy transfer to the target nucleus. The interactions resulted in the rapid breakup of the nucleus into many nuclear particles. A large abundance of deuterons in the considered momentum interval was observed (1.6±0.3 per star). The results are compared with those obtained previously in the study of other types of interactions and are interpreted in terms of the Butler–Pearson mechanism. Author (NSA)

N67-38642# Tokyo Univ. (Japan). Inst. for Nuclear Study.
THEORY OF THE RESONANT BEAM EJECTION FROM AG SYNCHROTRON
Y. Kobayashi Aug. 1966 50 p refs
(SJC-A-66-1)

An analytical treatment of the resonant beam extraction from AG synchrotrons based on an approximate Hamiltonian and its application to integral, half-integral, and third resonance extractions is presented. NSA

N67-38643# Hungarian Academy of Sciences, Budapest. Central Research Inst. for Physics.
TABLES FOR FAST IDENTIFICATION OF GAMMA-EMITTERS FROM THE COMBINED HALF-LIFE AND ENERGY DATA
G. Perneczky and P. Quittner 5 Apr. 1967 6 p refs
(KFKI-5/1967)

Tables are given for the rapid identification of gamma emitters, produced by (n,γ) and fast-neutron reactions, from their approximately known half lives and energies. Author (NSA)

25 PHYSICS, PLASMA

Includes magnetohydrodynamics. For applications see: 28 Propulsion Systems.

N67-35383*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland Ohio.
VOLUME ION PRODUCTION COSTS IN TENUOUS PLASMAS: A GENERAL ATOM THEORY AND DETAILED RESULTS FOR HELIUM, ARGON, AND CESIUM
John V. Dugan, Jr. and Ronald J. Sovie Washington, NASA, Sep. 1967 50 p refs
(NASA-TN-D-4150) CFSTI: HC $3.00/MF $0.65 CSCL 20I

A simple general theory for the volume ion production cost and ion production rate is presented for an arbitrary tenuous plasma having a Maxwellian distribution of electron energies. The ion production cost results are obtained by comparing the relative probabilities for the competing inelastic processes of excitation and ionization. The general theory treats a simplified atomic model and gives the volume ion production results for a general atom as a function of electron kinetic temperature. The results are shown to be in good agreement with those of more detailed calculations for helium, argon, and cesium gases. These detailed results are obtained by considering the discrete atomic structure of the target atoms and are presented for two distinct cases: (1) a monoenergetic electron beam incident upon a cold neutral gas, and (2) the interaction of a thermal electron gas with cold neutrals. The semiclassical Gryzinski method was used to determine theoretically the cross sections needed for the general atom theory and the detailed argon and cesium studies. Experimental excitation functions were used in the detailed helium calculations. The Gryzinski technique for calculating cross sections is discussed, and the results of this theory are compared with available experimental data. The Gryzinski method generally gives absolute cross sections that are good to within a factor of two or better. Its application should not introduce significant error in an eV/ion calculation, however, since the relative rates of the processes involved are of interest and not their absolute magnitudes. Author

N67-35386# Oak Ridge National Lab., Tenn.
VISCOUS ATTENUATION OF EXPLOSIVE SHOCKS IN TUBES
Lawrence Dresner Jun. 1967 20 p refs
(Contract W-7405-ENG-26; ARPA Order 907)
(ORNL-TM-1823) CFSTI: HC $3.00/MF $0.65

Measurements of shock arrival time and peak overpressure were made at distances up to 165 dia down shock tubes. At these distances, viscous drag at the walls markedly attenuates shock waves. Laws of propagation of plane blast waves are calculated for very strong and very weak shocks. Sources of error in numerical calculations of explosive shock propagation in the presence of the frictional force are discussed. Experimental results were compared with theoretical calculations and it was found that flow in explosive driven shock tubes is well described in the model used and that the friction factor in a 4 in. shock tube is ≈0.008 and the transition to turbulent flow occurs at ≈50 dia down the tube. NSA

N67-35563# General Electric Co., Philadelphia, Pa. Missile and Space Div.

BLOWING OF CURRENT PATTERNS IN NON-EQUILIBRIUM PLASMAS

Arthur Sherman and Hsuan Yeh May 1967 13 p refs
(Contract AF 49(638)-1609)
(R67SD28; AD-654861)

A description is given of some initial calculations of the displacement of current patterns in non-equilibrium plasmas due to a flow. Convection of energy is considered via the electron energy equation, but finite ionization rates are neglected. A pair of point electrodes in a parallel walled channel is chosen as a convenient problem to illustrate the solution procedure. It is found that the electron temperature distribution becomes skewed, the current displaced downstream, and the voltage to pass a given current is increased as the flow velocity becomes higher. Author (TAB)

N67-35631# United Kingdom Atomic Energy Authority, Culham (England). Research Group.

TURBULENT PROCESSES IN TOROIDAL SYSTEMS

B. B. Kadomtsev and O. P. Pogutse Mar. 1967 193 p refs Transl. into ENGLISH of Report of the Kurchatov Inst. (Moscow), IAE-1227, Oct. 1966 p 1-176
(CLM-TRANS-11; IAE-1227) CFSTI: HC $3.00/MF $0.65

All the principal types of instability which can occur in toroidal systems are considered. The linear theory of the instability of a toroidal column is discussed first. The results of the linear treatment are used as a basis for the subsequent investigation of turbulent processes. The macroscopic transport coefficients are determined and equations describing the plasma motion, including the effect of turbulent processes, are obtained. Author (NSA)

N67-35676# California Inst. of Tech., Pasadena.

COLLISIONLESS ABSORPTION AND EMISSION OF ELECTROMAGNETIC WAVES BY A BOUNDED PLASMA

F. L. Hinton May 1967 93 p refs
(Contract AF 49(638)-1462)
(AFOSR-67-1122; TR-7; AD-654314)

The absorption and emission of electromagnetic waves by a hot bounded plasma can be greatly influenced by the collective behavior of the plasma. A homogeneous slab model of a hot plasma is used in a theoretical study of these collective effects. A boundary-value problem is solved to find the fields in the plasma when a plane wave is incident on the plasma boundary. Power is found to be absorbed from the incident wave because of the Landau damping of longitudinal plasma waves excited in the plasma. If the incident wave frequency is close to one of the plasma wave resonance frequencies, the absorption may be substantial, but only if the Landau damping rate is approximately equal to the radiation damping rate, i.e., if the plasma is matched to the radiation field. The width of an absorption line is the sum of the Landau damping and radiation damping widths. Electromagnetic noise radiation is emitted from a collisionless plasma because of the coupling of the field fluctuations in the plasma to the external radiation field at the plasma boundary. Plasma wave fluctuations are excited by fast electrons in the plasma and are reinforced by the collective response of the plasma at the resonance frequencies. Emission and absorption are related by Kirchhoff's law for a thermal plasma. For a nonthermal plasma the emission may be enhanced if there are many electrons in a high-energy tail of the distribution function. Author (TAB)

N67-35679# Ballistic Research Labs., Aberdeen Proving Ground, Md.

SURVEY SPECTRA OF A PINCHED ARGON PLASMA

David B. Sleator and Robert A. Rudd Jun. 1967 24 p refs
(BRL-MR-1847; AD-654371)

Preliminary experiments were performed to determine the feasibility of measuring temperature in an argon theta pinch tube by the two-line ratio method. Calculations were made showing the temperature errors to be expected and the degree to which various types of thermal equilibrium exist as a function of time and electron density. Time integrated spectrograms were taken and a number of argon II lines were identified for which gf-values are known. Densitometer traces of the films indicated that the line shapes are suitable for the two-line method and an approximate calculation was made indicating a temperature of 35,000K. It was concluded that time resolved measurements would be desirable. Author (TAB)

N67-35798# Sheffield Univ. (England). Dept. of Fuel Technology and Chemical Engineering.

INTENTIONAL COMBUSTION OSCILLATIONS IN PROPULSION SYSTEMS Final Report

David Harris (Ph.D. Thesis) 28 Feb. 1967 167 p refs
(Grant AF-EOAR-66-11)
(HIC-92; AFOSR-67-1546; AD-655090)

Combustion oscillations for the improvement of the conventional MHD open cycle may be used. The resulting pressure modulation of the plasma can circumvent the sigma-e(U sq.) limitation of the classical generator by the possibility of increasing both conductivity (sigma-e) and gas velocity U over that of the steady flow case. The conductivity amplitude (delta-sigma)/sigma-eo was measured experimentally and plotted against the pressure amplitude (delta P)/P for a vortex MHD generator modulated by the first order travelling tangential mode of combustion oscillation. Author (TAB)

N67-35842# Brookhaven National Lab., Upton, N. Y.

NON-EQUILIBRIUM IONIZATION BY METASTABLE EXCITED SPECIES IN NUCLEAR MHD CYCLES

B. Manowitz, J. Powell, and M. Zucker 10 Mar. 1967 50 p ref Presented at the Magnetohydrodyn. and Electrohydrodyn. Steering Comm., Upton, N. Y.
(BNL-11300; CONF-670317-1) CFSTI: HC $3.00/MF $0.65

The possibility of non-equilibrium ionization by metastable excited species for increased efficiency in an MHD generator is discussed. Considerations are given to theoretical calculations of conductivities, experiments, and applications to nuclear systems. NSA

N67-35863*# Pennsylvania Univ., Philadelphia. Inst. for Direct Energy Conversion.

ON THE ONE-DIMENSIONAL MAGNETOHYDRODYNAMIC FLOW IN AN ANNULUS

S. Schweitzer and I. M. Cohen Aug. 1967 18 p refs
(Grant NsG-316)
(NASA-CR-88198; INDEC-53) CFSTI: HC $3.00/MF $0.65 CSCL 20I

Inviscid flow in the circumferential direction of a liquid conductor, confined between two concentric cylindrical electrodes and driven by the Lorentz force created by crossed electric and magnetic fields, is considered. It is shown that, in general, no well-behaved solutions exist to the inviscid problem without secondary flow. Two special solutions are given corresponding to zero field and zero current degeneracies of the governing equations and boundary conditions. It is also shown that hydro-static equilibrium is incompatible with current flow, even when no external magnetic fields are applied. An additional boundary condition on the radial magnetic field is also derived as a consequence of the basic formulation. Author

N67-35875*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

EFFECT OF GYRO-VISCOSITY ON RAYLEIGH–TAYLOR INSTABILITY OF A PLASMA

N. K. Nayyar and S. K. Trehan Aug. 1967 20 p refs

(NASA-TM-X-55906; X-640-67-384) CFSTI: HC $3.00/MF $0.65 CSCL 20I

The effect of finite ion Larmor radius on the development of Rayleigh–Taylor instability of a plasma bounded by a vacuum is studied. The macroscopic equations of motions are used where the finite ion Larmor radius effect is incorporated through off-diagonal terms in the pressure tensor in the momentum fluid equations. The effect of the finite Larmor radius stabilization of the interchange mode is demonstrated. For disturbances propagating along the magnetic field it is found that the inclusion of gyro-viscosity has the effect of reducing the instability of plasma vacuum interface. Author

N67-35893*# Maryland Univ., College Park. Dept. of Physics and Astronomy.

THE CONSTRUCTION AND GENERAL PROPERTIES OF A BRUSH CATHODE DISCHARGE

Joseph P. Bingham (M.S. Thesis) Aug. 1967 57 p refs

(Grant NGR-21-002-060)

(NASA-CR-88266; TR-719) CFSTI: HC $3.00/MF $0.65 CSCL 20I

The use of a brush cathode in a DC glow discharge allows stable operation in the abnormal glow region. In a strongly abnormal glow discharge, the negative glow becomes quite extensive, and is useful as a laboratory plasma. A brush cathode DC glow discharge tube, 6 inches in diameter and 24 inches in length, was constructed for the present experiment. The tube operated stably in the abnormal glow region and large negative glows were produced. Langmiur probe studies of the negative glow plasma at pressures less than 400 μ and discharge currents less than 2 ma yielded electron temperatures and densities of about 700°K and 10^8/cc respectively. At greater discharge currents and pressures, the Langmuir probe measurements were unreproducible, probably because condensable vapor impurities formed a surface film on the probe. Such a film could cause a change in the probe contact potential and thus affect the probe characteristics. Author

N67-35899# Aerospace Corp., El Segundo, Calif. Aerodynamics and Propulsion Research Lab.

A PRESSURE GAUGE FOR PLASMAS SUBJECTED TO LARGE DYNAMIC ELECTRIC AND MAGNETIC FIELDS

Wallis R. Grabowsky, Donald A. Durran, and Marquis E. Gerard Feb. 1967 12 p refs

(Contract AF 04(695)-1001)

(TR-1001(2240-10)-8; SSD-TR-67-88; AD-654284)

A static pressure gauge, comprised of a transducer and a resistance bridge, for use in high-temperature (4000K), high-pressure (0.5 to 10 atm), plasma flow of short duration (10 msec) is described. The transducer is electrically insulated from the flow and used when the plasma is 1 kV above the instrumentation reference. The gauge output is free of negative pickup when used in a 4, 0-Wb/sq m time-varying, crow-barred sinusoidal negative field of 4-msec quarter wavelength. Author (TAB)

N67-35942# Maryland Univ., College Park. Inst. for Fluid Dynamics and Applied Mathematics.

MATHEMATICAL MODELS FOR NONLINEAR MODE INTERACTIONS IN BOUNDED PLASMAS

Herbert Lashinsky Oct. 1966 40 p refs Presented at the NATO Advanced Summer Inst. on Nonlinear Phenomena in Plasmas, Orsay, France, 5–23 Sep. 1966 Submitted for publication

(Contract AT(40-1)-3405; Grant AF-AFOSR-106-67)

(BN-473; AD-654198)

Mathematical models are derived which reproduce a number of physical phenomena that have been observed in experiments on instabilities in continuously operating (cw) plasma devices. Of particular concern is the description of self-excited, steady-state oscillation in systems that can oscillate in more than one mode simultaneously. Although many of the experimental results are derived from work with a thermal plasma device (Q-machine), the general approach should be useful for other situations in which quasi-stationary oscillations are observed experimentally. The central point of the entire analysis is the description of the temporal behavior of the normal mode or eigenfunction by the Van der Pol equation. TAB

N67-35956*# Harvard Univ., Cambridge, Mass. Div. of Engineering and Applied Physics.

THEORETICAL AND EXPERIMENTAL STUDY OF A FINITE CYLINDRICAL ANTENNA IN A PLASMA COLUMN

Chung-yu Ting, B. Rama Rao, and W. A. Saxton Jul. 1967 53 p refs

(Grant NGR-22-007-056)

(NASA-CR-88202; SR-1) CFSTI: HC $3.00/MF $0.65 CSCL 20N

In the theoretical analysis, the plasma is approximated as a dielectric medium with relative dielectric constant $1-\omega_p^2/\omega^2$. The current distributions as well as the input admittances are obtained by a numerical method for both the cases $\omega>\omega_p$ and $\omega<\omega_p$. Experimental work is done by extending a coaxially driven cylindrical antenna into a coaxial glass tube which contains the plasma. Langmuir probe and cavity perturbation techniques are used in the diagnostic measurements. The current distributions and input admittances of the antenna have been measured for various pressures and discharge currents. The experimental results show a reasonable degree of qualitative agreement with the theoretical results. Author

N67-36030*# Michigan Univ., Ann Arbor. Dept. of Aerospace Engineering.

KINETIC EQUATION FOR A PLASMA AND ITS APPLICATION TO HIGH-FREQUENCY CONDUCTIVITY

J. H. M. Fu, R. L. Guernsey (Maryland Univ., College Park), and R. S. B. Ong Apr. 1967 103 p refs

(Grants NsG-220-62; AF-AFOSR-825-65; AF-AFOSR-825-67)

(NASA-CR-88132) CFSTI: HC $3.00/MF $0.65 CSCL 20I

A kinetic equation for an inhomogeneous and non-isotropic plasma is derived in the plasma limit. The treatment is based on the joint solution of the first two members of the BBKGY hierarchy, and on a linearization procedure about the unperturbed state. The unperturbed distribution functions, $f_0(\eta)$ and $g_0(\eta, \eta', \underline{r}-\underline{r}')$, are unspecified. The unperturbed pair correlation function, $g_0(\eta, \eta', \underline{r}-\underline{r}')$, is eliminated in favor of the unperturbed one-particle distribution function, $f_0(\eta)$. This elimination is accomplished by solving the equation for $g_0(\eta, \eta', \underline{r}-\underline{r}')$. The resulting kinetic equation is free from Bogolyubov's adiabatic hypothesis; therefore, it is valid for arbitrary frequency. In the limiting case when the frequency under consideration is much higher than the collision-frequency, a general expression for the high-frequency electric conductivity tensor is derived. From this general expression the results for the homogeneous and isotropic case previously derived by Klevans and Wu, as well as the results for the thermodynamic equilibrium case derived by Oberman, Ron, and Dawson can be recovered. Author

N67-36035*# Miami Univ., Coral Gables, Fla. Center for Theoretical Studies.

LANDAU DAMPING IN A RELATIVISTIC PLASMA

Behram Kursunoğlu May 1967 11 p refs

(Contract NGR-10-007-010)

(NASA-CR-88269) CFSTI: HC $3.00/MF $0.65 CSCL 20I

The paper shows that over a time interval $\tau=4$ mc/e|E| the phenomenon of Landau damping, for electron mass small

compared to kT, can induce a cooling mechanism in a relativistic plasma by an amplification of longitudinal as well as of transverse waves. Author

N67-36046# Ceskoslovenska Akademie Ved, Rez.
STRONG TURBULENCE OF AN INHOMOGENEOUS WEAKLY IONIZED PLASMA IN CROSSED ELECTRIC AND MAGNETIC FIELDS
V. Kopecky and V. Vaclavik Jan. 1966 24 p refs
(IPPCZ-48)

Instability of the drift-dissipative type, of a weakly ionized nonisothermal plasma in crossed electric and magnetic fields has been studied in the quasi-classical approximation for two cases: (a) $\Omega_e\tau_e>>1$, $\Omega_i\tau_i>>1$, and (b) $\Omega_e\tau_e>>1$, $\Omega_i\tau_i<<1$. The increment and frequency of the instability of such a plasma against potential disturbances have been deduced in the linear approximation. Equations of strong turbulence evolved with the aid of Mikhailovski's diagram method have been used in estimating the maximum valve of the spectrum function of the electric field of oscillations and of the coefficient of turbulent diffusion. A set of equations of strong turbulence are presented in the dimensionless form suitable for computer analyses. Author (NSA)

N67-36048# Los Alamos Scientific Lab., N. Mex.
SOURCE OF NEUTRONS BY PLASMA FOCUS: DESIGN AND FIRST RESULTS
C. Patou, A. Stmonnet, and J. P. Watteau 19 Jul. 1967 66 p refs Transl. into ENGLISH from the French Rept.-66-12/DO-034/W/PG
(LA-Tr-67-42; Rept.-66-12/DO-034/W/PG) CFSTI: HC $3.00/MF $0.65

The performances of various neutron sources are compared. After a short summary of the phenomena of self-striction, various theoretical models are considered which make it possible to take into consideration the mechanism governing a rapid electric discharge with non-cylindrical symmetrical geometry. The experimental arrangement is described. A theoretical model has been chosen (snow plow model) to support a numerical calculation. The results obtained from this model are compared to the experimental results. The various possibilities of improving the performance of this source are considered from the point of view of use. Actually, for an electrical energy of 15 kJ, 10^9 neutrons were obtained for 4π steradians, the emission lasting 100 ns, that is, 10^{16} neutrons per second in 4π steradians. Author (NSA)

N67-36236*# Princeton Univ., N. J. Dept. of Aerospace and Mechanical Sciences.
PULSED ELECTROMAGNETIC GAS ACCELERATION
Semiannual Progress Report, 1 Jan.–30 Jun. 1967
Robert G. Jahn and Woldemar F. Von Jaskowsky 1 Jul. 1967 92 p refs
(Grant NsG-306-63)
(NASA-CR-88199; Rept.-6341; SAPR-10) CSCL 20I

Spontaneous transition of propagating, "snowplowing" current sheets; typical of pulsed plasma accelerators, to steady, diffuse current patterns which accelerate plasma through themselves, has been achieved in a parallel plate geometry. This stabilization effect is accessible to detailed study, and a sequence of Kerr-cell, magnetic probe, and inner voltage divider studies have yielded some details of the transition process. The familiar transverse, propagating luminous front is found to lapse into more diffuse, nearly streamwise luminous bands near the electrode surfaces. The current density pattern also diffuses, and attains a bowed configuration. Voltage signatures across the electrodes indicate that the inductive contribution of the propagating current sheet is replaced by a motional or back emf. The persistence of plasma acceleration throughout the entire discharge duration is confirmed. Author

N67-36444# Alberta Univ., Edmonton. Dept. of Physics.
INTERACTION BETWEEN LONGITUDINAL AND TRANSVERSE PLASMA WAVES
Som Krishan and A. A. Selim May 1967 13 p refs Supported in part by the Natl. Res. Council of Canada
(Contract Nonr-4072(00))
(AD-654525)

The rate at which energy is fed into the transverse waves due to interaction with longitudinal waves is calculated for the case of an infinite, homogeneous isotropic, collisionless plasma. The method is based on constructing the Hamiltonian for the system in terms of creation and annihilation operators of second quantization. It turns out from the Hamiltonian that the dominate mechanism is the one in which two longitudinal waves collide to yield one transverse wave. Thus, in general the energy transfer rate decreases with time. In the limit t omega subscript p is very much < 1, the results agree with the previous work. Author (TAB)

N67-36475# Oregon Univ., Eugene.
A NOTE ON THE SPECTRUM OF THE LINEARIZED BOLTZMANN EQUATION FOR THE HARD SPHERE CASE
C. C. Yan and G. H. Wannier [1967] 15 p refs
(Contract Nonr-2771(05))
(TR-11; AD-654185)

The relaxation rates of the linearized Boltzmann equation for hard spheres are calculated for the first three angular indices by successive approximations, based on the Ritz variational principle. The first approximation shows a degeneracy between the angular indices l=0 and l=1; the value for l=2 lies in the continuum that is known to dominate the spectrum of hard sphere molecules. It is then shown that the degeneracy is an apparent one that arises from the low order of approximation employed. In second approximation, this degeneracy is removed; and the value for l=2 comes to be much closer to the edge of the continuum, although it does not get out of it. Author (TAB)

N67-36515# Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany).
DOCUMENTATION OF PLASMA PHYSICS. PART I: EXPERIMENTAL PLASMA PHYSICS, THEORETICAL PLASMA PHYSICS. BIBLIOGRAPHY, AUTHOR INDEX, SUBJECT INDEX
D. Hilsenbeck Apr. 1967 140 p refs
(AED-C-03-07, Pt. I, Vol. II)

A bibliography is presented of 302 papers on various aspects of plasma physics. Author and subject indexes are included. NSA

N67-36526# Akademiya Nauk SSSR, Novosibirsk. Institut Yadernoi Fiziki.
EFFECT OF ION VISCOSITY ON DESTABILIZATION OF SONIC OSCILLATIONS IN MAGNETIZED PLASMA [ROL'VYAZKOSTI IONOV V DESTABILIZATSII ZVUKOVYKH KOLEBANII ZAMAGNICHENNOI PLAZMY]
S. S. Moiseev 1966 6 p refs In RUSSIAN Submitted for publication
(NP-16768)

The ion viscosity may be the cause of the dissipative instability of an inhomogeneous plasma. In the frequency range of $\omega \approx k_z v_{Ti}$ (whereby ω is the perturbation frequency, k_z the projection of the wave vector and v_{Ti} the thermal velocity of the ions) no instabilities related to the ion viscosity have been observed; on the other hand, there is a great interest in this range because of its importance for installations with crossed lines of force or with a periodic curvature of the magnetic field lines. Assuming that the plasma temperature is uniform, the role of the ion viscosity in this frequency range was investigated by means of the hydrodynamic approximation for the potential perturbation. The calculations

indicated that if $\omega_i < k_z v_i$, consideration of the heat conductivity of the ions along $\vec{H}^0$ and of the ion viscosity related only to the longitudinal motion, results in the stabilization of the instability. From this, it could be shown that in devices with crossed lines of force, the instability yields an anomalous diffusion coefficient which may be much larger than the classic diffusion coefficient. NSA

N67-36533# Nagoya Univ. (Japan). Inst. Plasma Physics.
ANNUAL REVIEW, APRIL 1965–MARCH 1966
Mar. 1966 104 p refs

The Annual Review, covering the period April 1965 to March 1966, is presented by the Institute of Plasma Physics, Nagoya University, Japan. Summary results are provided on an experimental study of the ion cyclotron waves excited by a radio frequency oscillator of small output power, in a plasma column. Theoretical and experimental details are also given on such investigations as: ion cyclotron resonance heating of plasma, particle detector, behavior of plasma in S region, microwave interferometer, small mirror field over the anode hole, instability of hot electron plasma, negative absorption in partially ionized bases, and infrared gas lasers. R.U.

N67-36586* Farnham (Frank C.) Co., Philadelphia, Pa.
PARTICLE LOSS MECHANISMS IN A WEAKLY IONIZED TOROIDAL MAGNETOPLASMA [LADUNGSTRAGERVERLUSTMECHANISMEN IN SCHWACHIONISIERTEN TOROIDALEN MAGNETOPLASMA]
F. Karger Washington, NASA, Aug. 1967 54 p refs Transl. into ENGLISH from Gorman
(Contract NASw-1497)
(NASA-TT-F-11113) CSCL 20I

Discrepancies between theory and experiment on investigating the positive column in a curved magnetic field are ascribed to the fact that the plasma concentrates at the cathode end of the magnetic field coils. This influences the form of the transverse density profile and the stability behavior. A special alternating field method eliminated the influence of this concentration effect on the measurements of interest and increased the critical magnetic field strength for the onset of the helical instability of the positive column. The theoretically predicted transverse electric field strength leading to the torus drift was observed, but the outward density displacement due to the torus drift did not occur. The influence of the toroidal curvature on the magnetic field strength and on the turbulent state of the positive column was investigated, and the influence of the grad ξ effect on the helical oscillation was verified. Author

N67-36591 Paris Univ., Orsay (France). Plasma Physics Lab.
ACTION OF AN ALTERNATE ELECTRIC FIELD ON WEAKLY IONIZING GAS, INHOMOGENEITY AND ANISOTROPY—PRODUCTION OF HARMONICS [ACTION D'UN CHAMP ELECTRIQUE ALTERNATIF SUR UN GAZ FAIBLEMENT IONISE, INHOMOGENE ET ANISOTROPE—PRODUCTION D'HARMONIQUES]
J. L. Delcroix and A. M. Pointu Jul. 1966 32 p refs In FRENCH
(LP-60)

The effect of inhomogeneities and the action of an alternating electric field on a weakly ionized gas are examined. Two cases are considered: where the gradient is parallel to $\vec{E}$, and where the gradient is perpendicular to $\vec{E}$. Equations are formulated for the equilibrium state in the absence of a field and of inhomogeneities, for the harmonic current, and for the equilibrium function in the presence of inhomogeneities. Anisotropic coefficients are developed to determine the parameters of the electric field diffusion. As an example, an application to a propagation problem is given. Transl. by M.G.J.

N67-36623# Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research.
USE OF A MONOCHROMATOR FOR THE VELOCITY AND TEMPERATURE MEASUREMENTS IN A COAXIAL PLASMA ACCELERATOR
S. Kulinski, J. Nowikowski, and S. Suckewer 1967 26 p refs
(INR-781/XVIII/PP)

The axial speeds of different groups of ions as a function of a delay time τ for two test gases, hydrogen and air, were measured in a coaxial plasma gun with the aid of monochromator. At least two plasmoids were observed: a slow one propagating with the speed of about 2×10^6 cm/sec and a fast one with the speed of about 5×10^6 cm/sec. The speeds of different ions were approximately equal for a given plasmoid. The qualitative discussion of the obtained results based on the single particle model of acceleration is given. It indicated that two groups of accelerated particles can emerge from the gun, one in which the energy of a particle is proportional to its mass and another one with the energy independent of the mass of a particle but proportional to its charge. Author (NSA)

N67-36626# Institut für Plasmaphysik G.m.b.H., Garching (West Germany).
DOCUMENTATION OF PLASMA PHYSICS. PART I: EXPERIMENTAL PLASMA PHYSICS, THEORETICAL PLASMA PHYSICS. VOLUME II: BIBLIOGRAPHY, AUTHOR INDEX, SUBJECT INDEX
D. Hilsenbeck Mar. 1967 126 p refs
(AED-C-03-06, Pt. 1, Vol. 2)

A bibliography containing 291 articles on various aspects of plasma physics is presented. Author and subject indexes are included. NSA

N67-36631# Stevens Inst. of Tech., Hoboken, N. J. Dept. of Physics.
INVESTIGATIONS IN PLASMA DYNAMICS Annual Progress Report
George Schmidt Apr. 1967 8 p refs
(Contract AT(30-1)-3785)
(SIT-3785-3) CFSTI: HC $3.00/MF $0.65

Brief summaries are presented on the following areas of research conducted during this period: guiding-center treatment of finite gyro-radius fluid equations and limiting growth rates for electrostatic instabilities in a relativistic electron plasma with a loss cone distribution function. NSA

26 PHYSICS, SOLID-STATE

Includes semiconductor theory; and superconductivity. For applications see: 18 Masers. For related information see also: 10 Electronics.

N67-35339# Naval Ordnance Lab., White Oak, Md.
CANONICALLY CONJUGATE VARIABLES FOR THE FINITE STRAIN PROBLEM
Paul Harris 31 May 1967 19 p refs
(NOLTR-67-61; AD-654573)

Internal position-like variables are derived for phonons, and for electrons in a crystalline lattice. The derivation proceeds by considering departures from translational invariance. The importance

of such internal variables is discussed. Advice is given to experimentalists in the area of measuring the electron current dragged along by the mechanical shock. TAB

N67-35344# American Optical Co., Southbridge, Mass. Research Div.

ESR AND OPTICAL ABSORPTION STUDIES OF TRANSITION METAL IONS AND COLOR CENTERS IN GLASS Semiannual Technical Report, 1 Oct. 1966–31 Mar. 1967

Elias Snitzer, Robert J. Landry, and Joseph T. Fournier Mar. 1967 52 p refs

(Contract N00014-67-c-0186; ARPA Order 306; Proj. Defender)

(TR-599-1; SATR-1; AD-654576)

The theory of zero field ESR measurements of an S = 3/2 system is considered, including spectrometer considerations. A brief discussion of an experimental problem associated with temperature dependent ESR intensity measurements of broad powder spectra is included along with a proposed solution. The optical absorption and ESR spectra of Mo(5+) and Cu(2+) in glass, in the concentration range 0.1-16.0 wt. % MoO3 and CuO, respectively, were investigated. In both cases, the ESR spectra are found to be concentration dependent. For isolated Cu(2+), the axial spin Hamiltonian parameters obtained are: g parallel to = 2.335 plus or minus 0.002, g perpendicular to = 2.050 plus or minus 0.001, A parallel to = 155 plus or minus 1 x 0.0001/cm, and A perpendicular to = 22.7 plus or minus 0.1 x 0.0001/cm. ESR and optical absorption spectra of Mo(3+) in a phosphate glass are shown. The value of the crystal field splitting parameter delta is 22,000/cm, about 52% greater than the value of 14,500/cm for isoelectronic Cr(3+) in the same base glass. The spin resonance spectra of Cr(3+) and Mo(3+) are compared, from which it is concluded that they are similarly accommodated in the glass. Their local environments appear to be identical. A technique is described which allows for a precise determination of the activation spectrum for production of permanent color center defects by ultraviolet light. Author (TAB)

N67-35359# Utah Univ. Salt Lake City. Electrical Engineering Dept.

THE NONLINEAR MICROWAVE EFFECTS IN CONDUCTORS

Su-min Chou and Curtis C. Johnson Jul. 1967 92 p refs

(Grant NSF GK-717)

(NSF-12)

Nonlinear conductivity is expressed in terms of a Taylor's series expansion for σ with derivatives of σ with respect to H, and the theory of second and third harmonic generation is developed for thin film and bulk nonlinear conductors. Parametric interactions are also examined. Applications of the theory indicated for design of harmonic generation experiments and calculations of power and conversion efficiencies in terms of the σ versus H properties of the nonlinear conducting material. A quantitative explanation of the generation and propagation of harmonic waves in a nonlinear conducting sheet is given. Fortran programs for the calculation of transmitted and reflected power associated with thin films are included. E.C.

N67-35364 Technische Hochschule Munchen (West Germany).

MOESSBAUER EFFECT FROM Au^{197} IN THE PLATINUM LATTICE FOLLOWING LOW TEMPERATURE RADIATION WITH NEUTRONS [MOESSBAUER-EFFEKT VON AU 197 IN PLATIN-GITTER NACH TIEFTEMPERATUR-BESTRAHLUNG MIT NEUTRONEN]

Josef Ernst Weiser (Ph.D. Thesis) 1966 54 p refs In GERMAN

Low temperature neutron bombardment of gold in a platinum lattice resulted in a lowered Debye-Waller factor caused by the induced defects. Isomer shifts, quaropole splitting, and a change of width of the Mossbauer-γ-line were not observed. The changed Debye-Waller factor was attributed solely to fast neutron effects; gold ^{197} Mossbauer atoms, produced by the thermal neutrons, acted only as sonde for the middle amplitude quadrate of the platinum lattice oscillations. Transl. by G.G.

N67-35409# Cornell Univ., Ithaca, N. Y. Lab. of Atomic and Solid State Physics.

ON THE INTRINSIC RESISTIVE TRANSITION IN NARROW SUPERCONDUCTING CHANNELS

James S. Langer and Vinay Ambegaokar Jun. 1967 59 p refs

(Contract Nonr-401(38))

(TR-20; AD-654543)

We present a theory of current-reducing fluctuations in narrow superconducting channels. The theory is based on the Ginzburg-Landau equation, and is constructed in analogy with the droplet model of the condensation of a supersaturated vapor. Our theory suggests that large and improbable fluctuations are important, and cause measurable departures from the mean-field critical current. The calculation leads to a concrete result for the intrinsic resistive transition. This transition is predicted to occur at a temperature slightly lower than the bulk transition temperature, and to have a width which is observable but smaller than those measured in recent experiments. Author (TAB)

N67-35456# Iowa State Univ. of Science and Technology, Ames.

MOESSBAUER EFFECT STUDY OF THE MAGNETIC STRUCTURE OF SINGLE CRYSTAL ERBIUM

Richard Allan Reese (Ph.D. Thesis) Feb. 1967 90 p refs

(Contract W-7405-ENG-82)

(IS-T-117) CFSTI: HC $3.00/MF $0.65

The rare earth metal erbium exists in three magnetically ordered states below its Néel temperature of 85°K. The magnetic structure of these three states was studied using the Mössbauer effect with single crystal absorbers. The ratios of the areas under the hyperfine absorption maxima are related to the angle between the direction of magnetization and the gamma-ray propagation direction. By studying these area ratios it was possible to obtain information about the magnetic structures. In the low-temperature region (below 20°K), analysis of the data, on the assumption of a cone structure, yields a value of 26±3° for the semi-apex angle of the cone. In the intermediate temperature region (20 to 52°K), five line Mössbauer absorption spectra were obtained which were qualitatively similar to those obtained in the low-temperature phase. In the high-temperature phase, (52 to 80°K), a two line Mössbauer spectrum was obtained when the c-axis of the crystal was parallel to the gamma beam. For the heavy rare earths the hyperfine field is principally due to the polarization of the 4f electrons, so that the hyperfine field is proportional to the magnetic moment of the ion. The observation of a well-resolved spectrum indicates that the range of values for the hyperfine field is no larger than that found for the other two phases. The temperature dependence of the magnetic hyperfine field and the electric quadrupole interaction were measured between 4.2 and 80°K. Although the probable errors are quite large, a T^2 temperature dependence appears to fit the data better than a $T^{3/2}$ or a Brillouin function dependence. The value of the magnetic hyperfine field extrapolated to 0°K is $7.71 \pm 0.15 \times 10^6$ Oe. The quadrupole splitting decreases with temperature to about 50°K where it can no longer be separated from the experimental noise. Author (NSA)

N67-35458# Iowa State Univ. of Science and Technology, Ames.

THE CRYSTAL STRUCTURE OF $Ni(PO_3C_6H_9)_3(ClO_4)_2$

Ernest Frederic Riedel (M.S. Thesis) Feb. 1967 40 p refs

(Contract W-7405-ENG-82)

(IS-T-153) CFSTI: HC $3.00/MF $0.65

The structureof $Ni(PO_3C_6H_9)_5(ClO_4)_2$, pentakis-2,8,9-trioxa-1-phosphaadamantanenickel (II) perchlorate, has been determined by X-ray diffraction techniques. This compound crystallizes in the triclinic space group $P\bar{1}$ with cell parameters: a=11.53 ±0.05, b=18.92±0.07, c=12.61±0.05Å, α=96.40±0.5, β=103.40±0.6, and γ=96.90±0.5°. A total of 2300 reflections were observed and refined isotropically to give a final agreement factor of 15%. The central coordination about the nickel atom is trigonal bipyramid. The axial bond for the phosphorus atom was found to be shorter than the equatorial phosphorus atoms. The shortness of the axial Ni–P bonds suggests some dπ–dπ bonding between the nickel and the phosphorus. Considerations of interatomic repulsions suggest that trigonal bipyramid is more stable than the tetragonal pyramid configuration for the molecule.
Author (NSA)

N67-35465# Norwegian Defence Research Establishment, Kjeller.
FIELD DISTRIBUTION IN CDS AS DETERMINED BY AN OPTICAL PROBE
Hans-Jacob Fossum 20 Jan. 1967 20 p refs
(Contracts AF 61(052)-484; AF 61(052)-958)
(AFCRL-67-0359; SR-2; E-93; AD-654329)

The internal electric field distribution has been measured in photoconducting CdS single crystals using the linear electrooptic effect. The electrooptic effect in CdS is discussed in relation to the optical probe technique used. The experimental results show a nearly homogeneous field distribution in the crystals for applied fields below the threshold for acoustoelectric oscillations, while a high field region was created near the anode and a low field region in the cathode area for fields above the threshold field. The reproducibility from sample to sample was rather poor. The linear electrooptic constant was calculated from the experimental results: r(subscript 113) - r(subscript 333) = 2.7 x 10 to the -12th power m/V at the optical wavelength 6328 A. Intensity variation due to light absorption in the crystal and vibrations in the fundamental mode, was observed in some low conductivity samples.
Author (TAB)

N67-35483# Rutgers Univ., New Brunswick, N. J. Dept. of Physics.
GROUND-STATE ENERGY SHIFT IN SUPERCONDUCTOR DUE TO S–D INTERACTION
Sang Boo Nam and James Wing Fai Woo 15 Jun. 1967 8 p refs
(Contract Nonr-404(13); Grant NSF GP-4665)
(AD-654197)

The possibility that the s-d interaction gives rise to a bound state between conduction electrons and localized spin in a superconductor is discussed. It is shown that a singlet bound state is energetically favorable when lambda sub zero is greater than delta, where lambda sub zero is the binding energy of the singlet in the normal state and delta is the zero temperature BCS gap parameter.
Author (TAB)

N67-35492# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
CATHODE SPUTTERING OF TUNGSTEN [KATODNOYE RASPYLENIYE VOL'FRAMA]
J. A. Shustrov and A. Kh. Ayukhanov 23 Feb. 1967 11 p refs Transl. into ENGLISH from Dokl. Akad. Nauk Uz. SSR (Tashkent), no. 10, 1964 p 22–26
(FTD-HT-66-558; TT-67-62288; AD-655035)

The radioactive isotope method was used to investigate cathode sputtering of a polycrystalline tungsten target, the temperature of which was approximately 1800K. It is assumed that sputtering of a clean surface takes place at such a temperature. In order to prevent evaporation of the target, an instrument was constructed, which made it possible to measure simultaneously the amount m sub 1 of the material evaporated from one side of the target, and the amount m sub 2 of the material evaporated and sputtered during the same time from the opposite side. The amount of sputtered material was m = m sub 2 - m sub 1. The energy dependences of the coefficient W of sputtering of tungsten by ions Cs(+), Rb(+), K(+), and Li(+) is obtained. In the energy region 300-2500 eV, these dependences are represented by straight lines. A correlation is established between the value of the coefficient of cathode sputtering and the energy received by the target from the incoming ion in two successive collisions with the lattice atoms.
TAB

N67-35535# Princeton Univ., N. J. Frick Chemical Lab.
RAMAN SPECTRA OF POLYCRYSTALLINE CO_2 AND N_2O
Jerry E. Cahill, Kenneth L. Treuil, Richard E. Miller, and George E. Leroi Jul. 1967 10 p refs
(Contract Nonr-1858(27))
(TR-24; AD-655114)

Raman spectra were taken of polycrystalline CO2 and N2O in the lattice region at several temperatures. Each spectrum consists of three bands assigned as librational modes. The peak positions shift an average of 9% over an 80K temperature range.
Author (TAB)

N67-35544# Aerospace Corp., El Segundo, Calif. Electronics Research Lab.
TWO-PHOTON STEPWISE ABSORPTION IN ER3+ DOPED SALTS, APRIL–JUNE 1966
I. Richman and N. C. Chang Apr. 1967 17 p refs
(Contract AF 04(695)-1001)
(TR-1001(2230-25)-2; SSD-TR-67-52; AD-654283)

The ordinary fluorescence of Er(3+) in Y2O3 and LaF3 crystals is observed when the crystals are excited with 6328A He-Ne laser radiation. From the linear power dependence of the 6800A fluorescence and the quadratic power dependence of the 5640 and 3900A fluorescence on the 6328A excitation, a single photon excitation for the 6800A fluorescence and a double-photon stepwise excitation for the 5640 and 3900A fluorescence were proposed. The calculated photon flux of the 5640A fluorescence based on the two-photon stepwise excitation agrees with the estimated observed value.
Author (TAB)

N67-35589# Army Missile Command, Huntsville, Ala. Physical Sciences Lab.
SHAPE DEPENDENCE OF THE CONDUCTION BAND TAIL UPON DONOR CONCENTRATION IN GALLIUM ARSENIDE
Horst R. Whitman 10 May 1967 19 p refs
(RR-TR-67-9; AD-655112)

The spectral dependence of the optical absorption in compensated gallium arsenide and of the spontaneous emission from p-n junctions of gallium arsenide indicates the existence of a donor band tail which extends into the forbidden gap. It was found that the shape of this band tail depends strongly on the donor concentration. The theory for transitions between a parabolic valence band and an exponentially-tailed conduction band contains a parameter ETA which describes the shape of this tail. The dependence of ETA on the donor concentration can be deduced by measuring absorption and electroluminescence of samples with different n-doping. Experimental data indicate that ETA = Cn to the 0.4th power. The same result was found theoretically under the assumption of a Gaussian tail having the width ETA. Experiments with a nearly saturated absorption in gallium arsenide can provide information about the density distribution of the tail and it can be checked experimentally whether the shape of the tail is described by an exponential or by a Gaussian function.
Author (TAB)

N67-35591*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

EXACT SEMICLASSICAL THEORY FOR GALVANOMAGNETIC EFFECTS IN METALS

Gale Fair and P. L. Taylor (Case Inst. of Tech.) Washington, NASA, Sep. 1967 10 p refs Sponsored in part by AEC

(NASA-TN-D-4166) CFSTI: HC $3.00/MF $0.65 CSCL 20L

From the linearized Boltzmann equation for the distribution function of conduction electrons under the influence of uniform electric and magnetic fields, a solution in closed form is obtained for the conductivity tensor which is valid for any magnetic field strength. This result is obtained without assuming the existence of a scattering relaxation time and is valid for an arbitrary Fermi surface, including those surfaces which support open electron trajectories for some orientations of the magnetic field. The starting point for this theory is the definition of an anisotropic vector mean free path and the assumption that this function may be expanded in powers of the magnetic field strength. The resulting power series for the electron current may be summed exactly by considering the complete set of eigenfunctions of a magnetic scattering operator. Author

N67-35625# Rensselaer Polytechnic Inst., Troy, N. Y. Dept. of Mechanics.

LAMB WAVE EXCITATION IN A 6-CONSTANT CUBIC CRYSTAL BY THE WEDGE METHOD

H. S. Paul and W. H. Hoppmann, II Aug. 1967 13 p refs

(Contract DA-30-069-AMC-589(R))

(AD-655149)

It is desirable to study the problem of wave transmission in materials described by constitutive equations which involve couple-stresses. Physical methods of wave excitation are already described in the literature. These may be adapted for studies of the materials of present interest. Accordingly, solutions of the equations of motion for elastic waves assumed to be excited in a 6-constant centro-symmetric cubic crystal are examined in the present report. The solutions will be of value in applying the experimental techniques of wave excitation. Author (TAB)

N67-35649 Massachusetts Inst. of Tech., Cambridge. Microwave and Quantum Magnetics Group.

EXCHANGE TORQUE, POWER AND MOMENTUM FLOW, AND STRESS IN A RIGID FERRIMAGNET

Frederic R. Morgenthaler Aug. 1966 53 p refs

(Contract AF 19(628)-5876)

(AFCRL-67-0255; SR-3; AD-655084)

A self-consistent formulation of the exchange energy density, effective exchange field, and Poynting vector is carried out, for a general ferrimagnet, in terms of the spin and orbital angular momentum densities. When there is more than one magnetic lattice or when the gyromagnetic ratios are tensor quantities, this formulation leads to an exchange energy density and Poynting vector that differ from those commonly employed. With the help of the correspondence principle and a quasi-particle interpretation of spin waves, a small-signal energy density, momentum density, and stress tensor are postulated for a ferrimagnet. The associated small-signal force density (postulated to equal the divergence of the stress tensor minus the time rate of change of the momentum density) is found to be the negative of the force density that accelerates the envelope of the spin wave packet and is interpreted as a reaction force density acting upon the lattice. A prediction is made that a magnon incident upon a surface of discontinuity such as a material-air interface, will exert an exchange-radiation pressure on it. Author (TAB)

N67-35650# Massachusetts Inst. of Tech., Cambridge. Microwave and Quantum Magnetics Group.

MAGNETOELASTIC PROPERTIES OF YIG AS A FUNCTION OF TEMPERATURE

Aryeh Platzker Jan. 1967 56 p refs

(Contract AF 19(628)-5876)

(AFCRL-67-0256; SR-4; AD-655085)

The temperature dependence of first order magnetoelastic constants (b sub 1, b sub 2) and second order elastic constants (c sub 11, c sub 12, c sub 44) of yttrium iron garnet is obtained from sound velocity measurements in the range 80-300k. The group velocity of selected magnetoelastic modes in single crystals is measured by an ultrasonic system at a frequency of 30MHz as a function of applied magnetic field and temperature. The elastic constants are found to increase monotonically by a small amount upon decreasing the temperature. A 3% change from the room temperature value is observed at 80k. The temperature dependence of the magnetoelastic constants as reported here is in good agreement with previously published values that were obtained by static (length changes vs. magnetic field) methods. For b sub 1 the values of 3,240,000 erg/cc at 296k and 2,200,000 erg/cc at 80k are obtained. For b sub 2 the values 7,260,000 erg/cc and 12,600,000 erg/cc respectively are obtained. The coupled mechanical-magnetic equations of motion are decoupled and a 3 x 3 matrix is found. The corresponding eigenvalues give the dispersion relations of a magnetoelastic wave propagation at an arbitrary direction with respect to the magnetic field and the crystal coordinates. Author (TAB)

N67-35657# Materials Research Corp., Orangeburg, N. Y.

THE GROWTH OF SINGLE CRYSTALS OF DOPED AND UNDOPED YTTRIA AND YTTRIUM ALUMINATE IN A HOLLOW CATHODE ZONE REFINER Summary Report, 1 Dec. 1965–31 Dec. 1966

Walter Class and Harvey R. Nesor Wright-Patterson AFB, Ohio, AF Mater. Lab., Apr. 1967 45 p refs

(Contract AF 33(615)-3369)

(AFML-TR-67-51; AD-654656) CFSTI: HC $3.00/MF $0.65

The investigation was concerned with the growth of yttrium aluminate and yttrium oxide crystals by a float-zone process. The molten zone was here produced by the bombardment of high energy electrons present in a hollow cathode discharge. This technique was successfully applied to the growth of yttrium aluminate crystals. The nature of the grown boules suggests that yttrium aluminate is incongruent in its melting behavior, but, nevertheless, amenable to growth by the float-zone process. The clear water-white yttrium aluminate crystals represent the first relatively large crystals of this compound to be grown. The hollow cathode discharge environment was found suitable to carry out the controlled zone melting of yttrium oxide. However, the crystals were found to crack under the influence of the relatively large thermal gradients inherent to this technique. The experimental results indicate that auxiliary heating will eliminate this problem. The development of a suitable means of providing this auxiliary heating has not been accomplished to the degree where un-cracked crystals can be grown. Author (TAB)

N67-35675# International Information, Inc., Philadelphia, Pa.

POLARIZATION OF LUMINESCENCE AND STRUCTURE OF MOLECULES

P. Feofilov [1967] 21 p refs Transl. into ENGLISH from Izv. Akad. Nauk SSSR, Ser. Fiz. (Moscow), v. 13, no. 1, 1949 p 33–42

(TT-67-62217; AD-654516)

The importance of the investigation of polarized luminescence in conjunction with studies concerning the structure of molecules

is discussed and illustrated by example. Topics include: the nature of elementary emitters, polarization diagrams, polarization spectra, the relative position of molecular oscillators. TAB

N67-35705# General Electric Co., Schenectady, N. Y. Research and Development Center.
FIELD EMISSION THROUGH ATOMS ABSORBED ON A METAL SURFACE
C. B. Duke and M. E. Alferieff Sep. 1966 64 p refs
(Rept.-66-C-325)

The effects of adsorbates on electron field emission in addition to work function alteration are investigated, using a one-dimensional, schematic model of the emission tunneling in which the adsorbate is replaced by a potential well centered outside the metal surface. The potential parameters are estimated in terms of the pseudopotential theory of metals. The results of calculations of the field emission probabilities and their interpretation are presented. A discussion is also given of the results of sample calculations of the emission current and energy distribution for both metallic and neutral adsorbates. N.E.N.

N67-35856# California Univ., Berkeley. Lawrence Radiation Lab.
VACANCY MODELS FOR CONCENTRATED BINARY ALLOYS
Ching-yao Cheng (Ph.D. Thesis) Apr. 1967 84 p refs
(Contract W-7405-ENG-48)
(UCRL-17462) CFSTI: HC $3.00/MF $0.65

Four models for estimating the effect of short-range ordering (or clustering) on the equilibrium concentration of vacancies in binary alloys are developed in terms of statistical thermodynamics. The smeared-displacement, simple-displacement, and modified vacancy–energy models assume that the energy to produce a vacancy can be estimated from the change in bond energy when an atom is displaced from the bulk of the crystal to the surface. Each model differs, however, relative to the details of the environment about vacancies that are taken into consideration. All models suggest that the vacancy concentration decreases as a result of ordering. The vacancy–energy model is physically more realistic and more detailed but somewhat less tractable than the other models. It assumes that the free energy to produce a vacancy depends primarily on the immediate environment of the vacancy. The models were used for estimating the effects of long-range ordering on the equilibrium concentration of vacancies in binary alloys with $L2_0$(bcc) or $L1_2$(fcc) lattice. NSA

N67-35871# California Univ., Los Angeles. Dept. of Physics.
ULTRASONIC ATTENUATION AT LOW TEMPERATURES IN POTASSIUM AND GOLD
Giovan Giuseppe Natale (Ph.D. Thesis) May 1967 125 p refs
(Contract Nonr-233(48))
(TR-217; AD-654184)

The present investigation is primarily an experimental study of the electron-lattice ultrasonic attenuation in potassium. The results indicate that the attenuation is higher than predicted by a factor of 1.6, with an experimental uncertainty of 10%. A study was also made, in both potassium and gold, of a strain amplitude-dependent attenuation which was present at liquid helium temperature and the results for this effect are in general agreement with the theoretical expectations. The values of the constants of the Granato-Lucke theory are given. Additional features of the ultrasonic absorption between 20 degrees K and 77 degrees K are discussed in terms of some theories of dislocation motion. The ideal electrical resistivity in potassium below approximately 7 degrees K is found to have a T to the 5th power dependence; at higher temperatures the dependence decreases and becomes about T to the 3rd power at 20 degrees K. The data agree within 5% with the Hasegawa theory between 4 degrees K and 20 degrees K. TAB

N67-35938# Naval Ordnance Lab., Corona, Calif.
SEMICONDUCTING THIN FILMS: AN ANNOTATED BIBLIOGRAPHY, 1956–1966
W. R. Turnbull 15 Jun. 1967 291 p refs
(NOLC-712; AD-655100)

A comprehensive bibliographic survey of the preparation, properties, applications, and theory of semiconducting thin films is presented. It is comprised of 976 references published in English and foreign language periodical literature between 1956 and December 1966. The abstracts are arranged by author under the following classes: (1) Elemental, (2) Group III-V, (3) Group II-VI, (4) group IV-VI, (5) Group IV-IV, and (6) miscellaneous compounds. All of the materials are indexed with the exception of the miscellaneous compounds (Groups I-V, I-VI, and I-VII). Author (TAB)

N67-35944*# Hiram Coll., Ohio. X-Ray Physics Lab.
DEFECT PRODUCTION IN SINGLE CRYSTALS RESULTING FROM ION BOMBARDMENT Semiannual Status Report, 1 Jan.–30 Jun. 1967
Lawrence B. Shaffer 31 Jul. 1967 29 p refs
(Grant NGR-36-019-001)
(NASA-CR-88112; SASR-2) CFSTI: HC $3.00/MF $0.65 CSCL 20L

Design details are presented on the 10 cm X-ray diffractometer, which consists of the scattering chamber, the detection electronics, a rotating anode X-ray tube, and the high voltage power supply. A theoretical evaluation is made of cesium gas scattering problems, and the experimental techniques to be employed are discussed. A formula is included for calculating the ratio of cesium atoms adsorbed on a monolayer to the number in the vapor state at 676°C and 1 atmosphere in a tube 0.555 cm diameter. M.G.J.

N67-35976*# California Univ., Santa Barbara. Dept. of Physics.
ELECTRONIC SPECTRA OF CRYSTALLINE NaCl AND KCl
D. M. Roessler and W. C. Walker [1967] 39 p refs
(Grant NsG-91)
(NASA-CR-88200) CSCL 20L

The real (ϵ_1) and imaginary (ϵ_2) parts of the dielectric response function, together with the energy loss function $\mathrm{Im}(1/\hat{\epsilon})$, of freshly cleaved single crystals of NaCl and KCl were obtained in the region 5–28 eV by Kramers–Kronig analysis of near-normal-incidence reflectance spectra. Data were obtained over the entire region at room temperature, and from 5–11 eV at 77°K. The low temperature spectra of both materials reveal a definite distinction between exciton and interband spectra. Fine structure corresponding to the n=1 and n=2 members of the $\Gamma_{15}(3/2)$ and $\Gamma_{15}(1/2)$ exciton series were clearly resolved at 77°K, using a spectral resolution of 2 Å. The oscillator strength available for interband transitions has been largely exhausted below 15 eV in both materials, and the reflectance and dielectric response have low magnitudes at higher energies. Plasma resonance effects occur in both materials, and were identified from the $\mathrm{Im}(1/\hat{\epsilon})$ function. The optical data are in good agreement with directly measured electron energy losses. Author

N67-36055# Laboratory for Electronics, Inc., Boston, Mass. Applied Research Dept.
RESEARCH IN FERROMAGNETICS—PART 1 Interim Scientific Report, Mar. 1965–Mar. 1966
Robert J. Spain, Claude P. Battarel, Harvey I. Jauvtis, Michael J. Marino, and Patrick J. Peoples Feb. 1967 130 p refs
(Contract AF 19(628)-4197)
(ISR-2; AFCRL-67-0204; AD-654681)

The report describes improvements in the domain tip propagation logic techniques which are made possible by means of

a two-layer magnetic film structure. The use of two coupled magnetic layers permits forces of interaction between domain tips which are significantly greater than those which are obtainable between adjacent propagation channels of a single film. This has led to the construction of reliable domain tip interaction inhibit gates which will operate over plus or minus 30% variations in drive field strength. Author (TAB)

N67-36063# Royal Radar Establishment, Malvern (England). Ministry of Technology.
R.R.E. NEWSLETTER & RESEARCH REVIEW
Mar. 1967 93 p refs
(Rept.-8) CFSTI: HC $3.00/MF $0.65

Developments in crystal growth; infrared detectors; lasers; transistor structures; computer aided design of MOS integrated circuits; pulsed radars; ionospheric backscattering; and field effect transistors, are reviewed. Areas covered include: (1) the effect of electric fields on optical absorption edges, (2) anisotropy in the conduction band g-value for indium antimonide, (3) storage element alloy films, (4) thermal patterns over water, (5) improvements in photolithography, (6) glow discharge techniques for microelectronics, (7) aircraft responses due to very short pulses, and (8) the field dependence of the drift velocity in gallium arsenide. Other work activities are also reviewed. L.S.

N67-36087*# Brown Engineering Co., Inc., Huntsville, Ala. Research Labs.
CONDUCTIVITY PHENOMENA IN POLYCRYSTALLINE ZINC OXIDE FILMS
M. L. McDaniel, R. R. Mitchell, and H. J. Watson Jun. 1967 28 p refs
(Contract NAS8-20166)
(NASA-CR-88107; R-237) CFSTI: HC $3.00/MF $0.65 CSCL 20L

Conductivity in thin zinc oxide films is found to increase as film thickness increases. An empirical relation expressing this phenomena is given along with a physical explanation. Time rate change of conductivity data and voluntary response due to incremental changes in pressure are briefly discussed. Author

N67-36093# Giessen Univ. (West Germany). Erstes Physikalisches Institut.
METHODS FOR MEASURING QUICKLY DECAYING LUMINESCENCE PROCESSES [MESSMETHODEN ZUR UNTERSUCHUNG SCHNELLER ABKLINGVORGAENGE]
A. Schmillen Mar. 1967 23 p refs In GERMAN; ENGLISH summary
(BMWF-FBK-67-17)

Two methods used for measuring quickly decaying luminescence processes of scintillators and some results are discussed. The first method, the phase fluorometric determination of decay times, reaches a time resolution of some 10^{-11} sec. The second method, the direct oscillographic registration, gives more detailed information, but using commercial photomultipliers it has a smaller time resolution of about 10^{-9} sec. With a special image converter developed in our laboratory and briefly reported in the following paper the time resolution is improved by about a factor of ten. As an example measurements on the single crystal system Brasan/tetracene are discussed. Author (NSA)

N67-36143# Bureau of Mines, College Park, Md.
THERMOELECTRIC PROPERTIES OF YTTRIUM-GROUP V AND YTTRIUM-GROUP VI BINARY AND TERNARY COMPOUNDS
Timothy J. Driscoll, Jr. and Lindsay D. Norman, Jr. Sep. 1967 18 p refs
(RI-7025)

The thermoelectric properties of yttrium monoarsenide, yttrium monoantimonide, and ternary materials from the Y–As–Se and Y–Sb–Te systems were investigated by the Bureau of Mines from room temperature to 1,000°C. The maximum calculated figure of merit for yttrium monoarsenide and yttrium monoantimonide was 2×10^{-5} ° C^{-1}. YAs and YSb were semimetallic conductors with low Seebeck coefficients and electrical resistivities. The values of the Seebeck coefficient and electrical resistivity of the Y–As–Se and Y–Sb–Te materials were between those of the yttrium selenides and tellurides and of YAs and YSb, respectively. The maximum power factor calculated for the Y–As–Se materials was 2×10^{-5} watt/cm ° C^2 which yielded an estimated figure of merit of 6×10^{-4} ° C^{-1}. Most of the Y–As–Se compounds had high Seebeck coefficients and moderately low electrical resistivities. The Y–Sb–Te materials were degenerate semiconductors with power factors of 6×10^{-6} watt/cm ° C^2 Author

N67-36161# Bell Telephone Labs., Inc., Whippany, N. J.
RECOMBINATION FLUORESCENCE IN IRRADIATED GaP AND UNIRRADIATED GaP, ZnTe, AND Si
John D. Cuthbert 31 Dec. 1966 51 p refs Prepared for Western Elec. Co., Inc., N. Y.
(Contract AF 19(628)-4157)
(SR-2; AFCRL-67-0293; AD-655097)

Effects of 400-keV electron irradiations on fluorescence due to S-Si donor-acceptor pairs in GaP at 4 degrees K are described. Reduction in intensity of cathodoluminescence as a function of wavelength was analyzed in terms of a simple model. From the observed removal rate of fluorescent pairs and the calculated production rate of displaced atoms it is concluded that each radiation-induced defect has nearly unit probability of killing the fluorescence of one S-Si pair. The model attributes the attenuation of fluorescence to a non-radiative Auger recombination mechanism. This particular Auger mechanism was discovered through studies of recombination kinetics of excitons bound at isoelectronic and neutral centers in GaP, ZnTe, and Si. For neutral defects, lifetimes of excitons bound to S in GaP and As in Si were measured to be much shorter at low temperatures than predicted from detailed balance and absorption measurements. TAB

N67-36176* National Aeronautics and Space Administration, Washington, D. C.
QUANTUM THEORY OF THERMOGALVANOMAGNETIC PHENOMENA IN METALS AND SEMICONDUCTORS. PART III: COMPARISON OF THEORY WITH EXPERIMENT [K KVANTOVOY TEORII TERMOGAL'VANOMAGNITNYKH YAVLENIY V METALLAKH I POLUPROVODNIKAKH. III. SRAVNENIYE TEORII S EKSPERIMENTOM]
G. I. Guseva and P. S. Zyryanov' Aug. 1967 16 p refs Transl. into ENGLISH from Phys. Status Solidi, v. 8, 1965 p 759–772
(NASA-TT-F-11158) CSCL 20L

A theoretical analysis is given of available experimental data on thermomagnetic phenomena in a quantized magnetic field, in comparison with data on thermogalvanomagnetic phenomena in metals and semiconductors reported earlier. Results of experiments with electronic germanium of low impurity concentration in their dependence on the magnetic field at various temperatures are plotted and tabulated, to demonstrate correctness of earlier calculation techniques for phonon–phonon relaxation in anisotropic and isotropic media. Author

N67-36305# Technische Hochschule Damstadt (West Germany). Institut fuer Technische Physik.

OPTICAL AND MAGNETIC PROPERTIES OF RARE EARTH COMPOUNDS

K. H. Hellwege, S. Huefner, and G. Weber *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 7–8 (See N67-36303 21-06)

The rare earth iron perovskites of dysprosium, erbium, and holmium were studied, and ground state splitting in these compounds and its temperature dependence were deduced from spectra. The triplet structure of all lines found up to 20°K for dysprosium aluminum perovskite is considered the result of an almost exact Ising type of interaction; and an exchange integral and the Néel temperature were determined for this compound. The hyperfine structure of various lines in holmium ethylsulfate and holmium chloride was resolved, and an isotope shift was observed in the absorption spectrum of $Eu^{2+}(CaF_2)$. As expected from the optical hyperfine structure measurements, magnetic susceptibility for holmium ethylsulfate reveals both one- and two-spin cross relaxation processes. Cross relaxation processes of very high order were found in $CeCl_3 \cdot 6H_2O$. M.W.R.

N67-36306# Pennsylvania State Univ., University Park. Materials Research Lab.

CRYSTAL FIELD SPLITTINGS OF Nd^{3+} IN $NdAlO_3$ AND Nd^{3+}: $LaAlO_3$

P. Sitaram, S. R. Polo, and W. B. White *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 9 (See N67-36303 21-06)

Optical spectra of Nd^{3+} in $NdAlO_3$ and $LaAlO_3$ were obtained. Both $NdAlO_3$ and $LaAlO_3$ have a rhombohedrally distorted perovskite structure in which the rare earth ion has 12 oxygen neighbors with site symmetry C_{3v}. Spectra were measured on single crystals (grown from a $PbO–PtF_2–B_2O_3$ flux by Remeika's method) and on powders pressed with KBr pellets over the spectra range of 3.2 to 0.35 microns and at temperatures down to 4°K. The energy states are defined by the set of quantum numbers, and matrix elements were calculated. The crystal-field parameters, the three Slater integrals, and the spin-orbit coupling constant were evaluated. Author

N67-36307# Grenoble Univ. (France). Laboratoire d'Electrostatique et de Physique du Metal.

MAGNETISM OF SOME RARE EARTH ELEMENTS AND IONIC COMPOUNDS UNDER PRESSURE

R. Pauthenet, D. Bloch, and F. Chaisse *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 10–17 refs (See N67-36303 21-06)

The effect of hydrostatic pressure upon the magnetic properties of several rare earth elements and rare earth ferrite garnets is discussed. Magnetic ordering points and saturation magnetization of dysprosium, gadolinium, holmium, and terbium are considered in terms of pressure variations. M.W.R.

N67-36308# Bell Telephone Labs., Inc., Murray Hill, N. J.

PROPERTIES OF THE RARE-EARTH METALS AND ALLOYS AT HIGH PRESSURES

D. B. McWhan *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 18–28 refs (See N67-36303 21-06)

Measurements of the pressure dependence up to 85 kbar of the Néel and Curie temperatures and crystal structures are reviewed. The materials studied include (1) the elements Eu, Gd, Tb, Dy, and Ho, (2) the Tb–Y alloy system, and (3) a series of alloys with equal average DeGennes function. The initial slopes (dT/dP) are approximately proportional to the average DeGennes function. A polymorphic transition from a hexagonal-close-packed structure to a Sm-type structure is found with increasing pressure in many of these alloys. The Sm-type phase does not exhibit ferromagnetism, but has two ordering temperatures. The higher ordering temperature of the Sm-type phase is 10% lower than that of the hcp phase, and the two ordering temperatures in the Sm-type phase differ by 17%. Author

N67-36309# Texas Univ., Austin. Dept. of Chemical Engineering.

MAGNETIC AND ELECTRICAL PROPERTIES OF SOME Yb–Sb PHASES

R. E. Bodnar, H. Steinfink, and K. S. V. Narasimhan *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 29–35 refs (See N67-36303 21-06)

(Grant NSF GK-1236)

Electrical and magnetic properties of seven intermediate phases in the ytterbium–antimony binary system are characterized, and valence variations of Yb in the alloys were studied from magnetic susceptibility data. Besides its trivalent behavior, Yb occurs in the divalent state where all the 4f electrons are paired and the atom is, therefore, not magnetic. In the trivalent state a theoretical moment of 4.5 Bohr magnetrons is generated by an unpaired electron. Magnetic susceptibility versus temperature curves are shown for the seven intermediate alloys. M.W.R.

N67-36310# Pittsburgh Univ., Pa. Dept. of Chemistry.

MAGNETIC AND CRYSTALLOGRAPHIC CHARACTERISTICS OF PRASEODYMIUM HYDRIDES

K. H. Mader and W. E. Wallace *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 36–47 refs Sponsored by AEC (See N67-36303 21-06)

Susceptibilities and lattice parameters are reported for a series of praseodymium hydrides represented by the formula PrH_x in which x varies from .99 to 2.57. Susceptibilities were measured from 4 to 300°K and at field strengths up to 21 kOe. The samples are two phase for $x < 1.85$. Curie–Weiss behavior is observed for all samples above 100°K, with slopes in fairly good agreement with that expected for an assemblage of free tripositive ions. Deviations occur below 100°K. The negative deviations are small and are thought to result from the crystal field interaction. The positive deviations are ascribed to a change of valence for Pr from +3 to +4. Magnetic, electrical, and crystallographic evidence is in accord with this postulate. There is no indication of magnetic ordering in the Pr hydrides at 4.2°K. This is attributed to weakness of the interactions and to the valance changes which reduce the atomic moment. Author

N67-36311# General Electric Co., Schenectady, N. Y. Research and Development Center.

MAGNETIC BEHAVIOR OF RARE EARTH COMPOUNDS WITH SINGLET CRYSTAL FIELD GROUND STATE

Bernard R. Cooper *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 48–57 refs (See N67-36303 21-06)

Susceptibility and high field magnetization expected for rare earth compounds with singlet crystal field ground state are discussed. Limitations of molecular field theory in treating exchange effects on the susceptibility, non-linear magnetization, and criterion for magnetic ordering in such systems are considered. Author

N67-36312# Rice Univ., Houston, Tex.

MICROWAVE ABSORPTION IN DYSPROSIUM SINGLE CRYSTALS

H. A. Blackstead and P. L. Donoho *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 58–67 refs (See N67-36303 21-06)

(Grant NsG-6-59)

Microwave power absorption at a frequency of 9.8 GHz was observed in single-crystal *c*-plane platelets of dysprosium at temperatures from 40°K to 179°K. At temperatures below 85°K, and for temperatures from 85°K to approximately 110°K with $H_{dc} > H_c$, a strong resonance line with a width of approximately 1 kOe was observed. This resonance, predicted from spin-wave analysis, is apparently related to the strong six-fold basal-plane anisotropy which is important below 110°K. With the dc field perpendicular to the rf field, and for temperatures above 110°K, there was no apparent field-dependence of the absorption for $H_{dc} < H_c$. At higher fields, however, the absorption increased rapidly, reaching a maximum at H_f, the field at which the fan structure has collapsed to ferromagnetic alignment. With further increase of the field, the absorption then decreased linearly. No absorption was observed above 179°K, the temperature for the transition from the helicoidal spin structure to the paramagnetic state. Frequency-dependence studies are in progress in the range 8 to 25 GHz. Author

N67-36313# Sandia Corp., Albuquerque, N. Mex.
NUCLEAR MAGNETIC RESONANCE MEASUREMENTS IN THE NaCl-TYPE RARE-EARTH GROUP VA INTERMETALLIC COMPOUNDS
E. D. Jones *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 68–77 refs Sponsored by AEC (See N67-36303 21-06)

The phosphorus nuclear magnetic resonance was observed in the paramagnetic state of NaCl-type rare-earth intermetallic compounds. The phosphorus Knight shifts were measured in the temperature range of 100 to 600°K. Analyzing the temperature dependent Knight shifts in terms of a uniform-conduction electron spin polarization model yielded values for the s–f exchange energy. The arsenic, antimony and bismuth Knight shift data in SmAs, SmSb, and SmBi are presented. For the Sm^{3+} compounds, theoretical predictions concerning the behavior of the temperature dependence of the Sm^{3+} spin $<S(T)>$ are verified. Author

N67-36314# Alberta Univ., Calgary.
EPR ANGULAR SPECTRA OF GADOLINIUM IN RARE-EARTH DOUBLE NITRATE SINGLE CRYSTALS
H. A. Buckmaster, J. C. Doring, and D. J. I. Fry *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 78–88 refs Sponsored in part by Natl. Res. Council of Can. (See N67-36303 21-06)

The 10GHz electron paramagnetic resonance spectra of the gadolinium ion (Gd^{3+}; ^8S) in isomorphic, diamagnetic lattices of hydrated, rare-earth double nitrate single crystals are reported. These lattices are of the form $M_2'''\ M_3''\ (NO_3)_{12}{\cdot}24\ H_2O$, where M''' is bismuth or lanthanum and M'' is zinc or magnesium. The ratio of Gd^{3+} to M''' ions was $\approx$ 0.1%. Experimental data for temperatures of 290°K and 77°K are fitted to the phenomenological spin-Hamiltonian for C_{3i} symmetry. The angular dependence of the spectra shows substantial variations from that predicted. These variations are not inconsistent with C_{3i} symmetry, but cannot be completely described by any spin-Hamiltonian of the above form. This raises doubts as to the usefulness of the spin-Hamiltonian formalism because the intrinsic symmetry of the terms is too high to describe the variations. Author

N67-36315# Oak Ridge National Lab., Tenn. Solid State Div.
TEMPERATURE VARIATION OF Gd ESR SPECTRA IN CUBIC AND AXIAL CRYSTALS
M. M. Abraham, L. A. Boatner, E. J. Lee, and R. A. Weeks *In its* 6th Rare Earth Res. Conf. [1967] p 89–100 refs Sponsored by AEC (See N67-36303 21-06)

The electron spin resonance of gadolinium was observed and the temperature variation of the splitting was studied in single crystals of CeO_2, ThO_2, CaF_2, and CaO, where the symmetry of the local crystalline field was cubic. Similar measurements were made on single crystals of $La(C_2H_5SO_4)_3{\cdot}9H_2O$, $LaCl_3$, and $LaBr_3$ in which the symmetry of the local field was axial. Absolute signs of spin Hamiltonian parameters have been determined from the relative intensity of the resonance lines at low temperature. Author

N67-36316# New Mexico State Univ., University Park.
THE M SERIES X-RAY EMISSION LINES OF THE RARE EARTHS
A. F. Burr *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 101–111 refs Sponsored in part by NAS-NRC (See N67-36303 21-06)

A review of the wavelengths and energy levels assigned to the M series X-ray transitions of the rare earths shows that the width and pronounced structure of the Mα line has made the determination of its wavelength difficult and has introduced some uncertainty in the value to be given to the $N_{VI, VII}$ energy level. This study extended a program of selecting the most probable values for energy levels and wavelengths of X-ray lines by using modified Moseley diagrams to include the information contained in adjacent elements. Revised Mα and Mβ wavelengths are given for a number of rare earths as well as revised $N_{VI, VII}$ energy levels and information on the origin of the structure of the Mα line in the rare earth region of the periodic table. Author

N67-36322# Sheffield Univ. (England).
MAGNETIC PROPERTIES OF DYSPROSIUM
R. G. Jordan *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 166–174 refs (See N67-36303 21-06)

Magnetic properties of several single crystals of dysprosium were investigated along the principal directions of the hcp. structure over the temperature range 4° to 300°K in applied magnetic fields up to 18 Koe. The measurements in the basal plane agree in general with the previous work. Along the *c* direction a small spontaneous moment is observed, appearing at 125±2°K, 89±3°K, and 88±4°K for the three crystals studied. The corresponding spontaneous moments at 0°K are 1.9±0.4 emu/gm, 2.7±0.3 emu/gm, and 2.6±0.3 emu/gm. An analysis of the results would seem to indicate that the transition from antiferromagnetism to ferromagnetism is controlled by the strong dependence of the indirect exchange interaction with lattice dimensions. On the basis of this analysis the ferromagnetic *c* axis lattice parameter has been calculated for $90°K \leq T \leq 179°K$. Author

N67-36328# Indian Inst. of Tech., Kanpur. Dept. of Chemistry.
ELECTRICAL PROPERTIES OF RARE EARTH OXIDES AND RELATED SYSTEMS
C. N. R. Rao, G. V. Chandrashekhar, P. N. Mehrotra, and G. V. Subba Rao *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 223–224 (See N67-36303 21-06)

Electrical conductivities of some rare earth sesquioxides, measured over a wide temperature range, show a break in the conductivity curve around 550°C that indicates a change in the conduction mechanism. Conductivity dependence on the oxygen partial pressure and thermoelectric power of the oxides were investigated, and Frohlich coupling constant calculations and transition probabilities show that the small polaron theory is applicable to these systems. Phase transformations cause breaks in the conductivity curves of the sesquioxides of lanthanum, neodymium, praseodymium, and samarium; but yttrium oxide conductivity data do not display such breaks. Moisture reduced the temperature of the phase transformation and the activation energy for the conduction

process. Crystal structures and electrical conductivities of stoichiometric oxides were compared with those of nonstoichiometric oxides; and conductivities of rare earth ferrites, manganites, and chromites were studied. M.W.R.

N67-36331# DuPont de Nemours (E. I.) and Co., Wilmington, Del. Central Research Dept.

Eu^{+3} FLUORESCENCE IN NON-RARE EARTH OXIDE HOSTS

Hans J. Borchardt *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 239–248 refs *Its* Central Res. Dept. Contrib. No. 1285 (See N67-36303 21-06)

Attempts were made to dope a variety of non-rare earth oxides with Eu^{+3}. Of 19 oxides, only ThO_2 gave a bright phosphor. Failure of the others is attributed to low Eu^{+3} solubility. The $(ThO_2)_{.98}(EuF_3)_{.02}$ is a highly efficient phosphor with a quantum efficiency of ca. 0.64 under 2537 Å excitation. It is the first high efficiency Eu^{+3} phosphor not to contain a second rare earth ion and to have such a low optimum Eu^{+3} concentration. Author

N67-36332# Army Electronics Command, Fort Belvoir, Va. Night Vision Lab.

ENERGY TRANSFER IN CRYSTALS DOUBLY DOPED WITH RARE EARTHS

L. Esterowitz, J. Bahler, and J. Noonan *In* Oak Ridge Natl. Lab., 6th Rare Earth Res. Conf. [1967] p 249–258 refs (See N67-36303 21-06)

Infrared quantum counter (IRQC) fluorescence may be increased by using two species of rare earth impurity ions. The effects on the energy cascade are studied as the sensitizer (Yb^{3+}) concentration is increased. In particular, level bypassing of the Ho^{3+} (activator), $^5F_5$ state is attributed to a resonant energy cross-relaxation process. Author

N67-36334# Lockheed Missiles and Space Co., Palo Alto, Calif.

CATHODOLUMINESCENCE OF RARE EARTH-ACTIVATED YTTRIUM OXIDE

R. A. Buchanan, K. A. Wickersheim, J. L. Weaver, L. E. Sobon, and E. E. Anderson *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 271–282 refs (See N67-36303 21-06)
(Contract AT(04-3)-674)

Optimum activator concentrations for electron excitation, emission spectra from 2500 Å to 3 microns, and lifetimes of principal emission lines, and efficiencies are reported in terms of the cathodoluminescence of rare earth activated yttrium oxide. Powders precipitated as oxalates and fired in air to form phosphors were studied. All rare earths in Y_2O_3 cathodluminescence exhibited a power efficiency which is constant to within a factor of about 7, although the rare earths near the center of the series were the most intense visible and ultraviolet emitters and those toward the ends of the series were the most intense infrared emitters. Gadolinium was found to have the largest energy gap and the longest decay time, and a general correlation was found between decay times and energy gap between emitting state and next lowest state. M.W.R.

N67-36336# Commissariat a l'Energie Atomique, Grenoble (France). Laboratoire d'Electrostatique et de Physique du Metal.

MAGNETIC PROPERTIES AND MAGNETIC STRUCTURES OF THE TCo_3 INTERMETALLIC COMPOUNDS, WHERE T IS A RARE EARTH METAL OR YTTRIUM

R. Lemaire, R. Pauthenet, J. Schweizer, and I. Silvera *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 295 (See N67-36303 21-06)

Magnetization of the rare earth TCo_3 compounds is measured at temperatures between 2 and 1000°K in magnetic fields up to 29,000 Oe. For compounds where T represents Dy, Er, Ho, or Tm, the curves depicting thermal variation of spontaneous magnetization show the ferrimagnetic character of such rare earth compounds. Curie temperatures, from 300 to 612°K, increase rapidly with the spin moment of the associated rare earth element. Coupling of the spins of the rare earth atoms with those of the Co atoms is antiparallel, and the intrinsic magnetic moment of the Co varies from one compound to another. M.W.R.

N67-36337# Commissariat a l'Energie Atomique, Grenoble (France).

THE MAGNETIC STRUCTURE OF $Fe_5Tb_3O_{12}$ AT 4.2°K

F. Tcheou, A. Delapalme, and E. F. Bertaut *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 296 (See N67-36303 21-06)

The magnetic structure of $Fe_5Tb_3O_{12}$ at 4.2°K is colinear in the ferrimagnetic iron sublattice but is non-colinear in the moments of Tb. There are Tb moments of $8.5 \pm 0.3\ \mu_B$ on a cone whose axis is a [111] direction, and whose angular opening is 30°. The non-colinear component S' of the Tb moment is in the (111) plane. There are six sublattices to consider, and the spins on C_2, C_3 and C'_2, C'_3 can be deduced from C_1 and C'_1 by rotations of 120° and 240°, respectively. The results of the effect of a magnetic field and of the change of temperature are reported. Author

N67-36338# United Kingdom Atomic Energy Authority, Harwell (England).

NEUTRON SCATTERING FROM PARAMAGNETIC TERBIUM

J. W. Cable, M. F. Collins, and A. D. B. Woods *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 297–306 refs (See N67-36303 21-06)

The energy distribution of neutrons scattered from a single crystal of terbium at about 660°K ($T_N = 230$°K) was studied as a function of momentum transfer (Q). The measurements were carried out using both a twin rotor time-of-flight spectrometer and a triple axis spectrometer. The distributions were approximately Gaussian in shape with an additional tail that is believed to be unconnected with the paramagnetic scattering and more likely with multiple or phonon scattering. The second moments of the energy distribution, as determined from fitted Gaussian curves, yield exchange interactions which are consistent with those deduced from the spin wave dispersion curves in the ferromagnetic state. The distributions contain a large Q independent component which arises from the anisotropy energy. Typical values of $(\langle n^2\ \omega^2 \rangle)^{1/2}$ near zone boundaries are ≈3.2 MeV. Author

N67-36339# Atomic Energy Commission Research Establishment, Riso (Denmark).

MAGNON DISPERSION RELATION IN RARE EARTH METALS FROM INELASTIC NEUTRON SCATTERING

H. Bjerrum Moeller, J. C. Gylden Houmann (Tech. Univ., Copenhagen), and A. R. Mackintosh (Tech. Univ., Copenhagen) *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 307–309 refs (See N67-36303 21-06)

Inelastic neutron scattering studies were made of magnon dispersion in pure Tb and a Tb-10% Ho alloy by both constant $\bar{q}$ and constant E methods. The dispersion curves at 90°K for the pure Tb in the ferromagnetic phase had a finite energy of zero at $\bar{q}$ because of magnetic anisotropy. There was a quadratic rise at low $\bar{q}$ and a pronounced kink in the c-direction, and the dispersion relations had a symmetry consistent with the spin space group. A tendency toward spiral ordering is reflected in the c-direction of pure Tb; and when 10% Ho is added this tendency is considerably enhanced so that the spiral structure stabilizes over a wider

temperature range. Peaks that decrease discontinuously at the spiral-ferromagnetic transition are attributed to the splitting of the energy bands of different spin in the ferromagnetic phase. A strong coupling between magnons and transverse phonons propagating in the c-direction observed in the alloy leads to mixed excitations and a splitting apart of the dispersion curves and is associated with the large spin deviations at the Ho sites in the resonant magnon modes. M.W.R.

N67-36340# Commissariat a l'Energie Atomique, Grenoble (France).
MAGNETIC BEHAVIOR OF TRIVALENT TERBIUM IN SEVERAL COMPOUNDS HAVING THE PEROVSKITE STRUCTURE
J. Sivardiere, J. Mareschal, S. Quezel-Ambrunaz, G. F. de Vries, and E. F. Bertaut *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 310 (See N67-36303 21-06)

Mention is made of the neutron diffraction study of a class of compounds, designated as $ATbO_3$, with deformed perovskite structure and with the A referring to Al, Co, Cr, Fe, Ga, or Mn. Ordering occurs at high temperatures in the A sublattice if A is a magnetic ion; and for the sublattices of Tb, there can be ordering when (1) the Tb is coupled with A in some instances and (2) independently of A when A is not magnetic. Néel temperatures and magnetic behavior of Tb are reported in the original study, for which a summary is included in this document. M.W.R.

N67-36362# Tokyo Univ. (Japan). Inst. for Solid State Physics.
EFFECT OF THE S–F EXCHANGE IN DILUTE ALLOYS
Kei Yosida *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 471–481 refs (See N67-36303 21-06)

It has been well established that the s–f exchange interaction between the conduction electrons and the localized spin of 4f-electrons plays a decisive role in the magnetic and electrical properties of rare earth metals and alloys. The s–f exchange interaction has a remarkable effect particularly in dilute alloys of rare earth in non-magnetic metals. Since Kondo has succeeded in explaining the resistivity minimum in dilute alloys of Mn and Fe in noble metals the effect of the s–f or s–d exchange on the electrical resistivity of dilute alloys has been investigated in detail by Suhl, Abrikosov, Nagaoka and many others. These investigations are reviewed in connection with dilute alloys of rare earths and recent experiments on this anomalous effect are also briefly mentioned. Author

N67-36363# Massachusetts Inst. of Tech., Cambridge. National Magnet Lab.
BAND STRUCTURE, FERMI SURFACE AND PHYSICAL PROPERTIES OF THE RARE-EARTH METALS
A. J. Freeman *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 482–486 Sponsored by AFOSR (See N67-36303 21-06)

A review is given of our present understanding of some of the electric, magnetic and optical properties of the rare-earth metals based on recent ab initio energy band calculations. Author

N67-36364# Iowa State Univ. of Science and Technology, Ames. Dept. of Physics.
POSITRON ANNIHILATION IN RARE EARTH SINGLE CRYSTALS
R. W. Williams and A. R. MacKintosh (Tech. Univ. of Denmark) *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 487–494 refs (See N67-36303 21-06)

We have measured the angular correlation of the photons emitted when positrons annihilate with electrons in single crystals of the rare earth metals Y, Gd, Tb, Dy, Ho and Er and also in single crystals of certain alloys. A comparison of the results for Y with the calculations of Loucks shows that the independent-particle model gives a good approximation to the angular distribution, although correlation effects probably smear out some of the details. The angular distributions in the c-direction in the paramagnetic phases show a rapid drop at low angles followed by a hump, and these features are associated with rather flat electron and hole regions of Fermi surface normal to the c-axis. There is a strong correlation between the size of the hump and the ability of the magnetic metals to form a periodic magnetic structure. In the spiral phase of Ho, the hump is much reduced, indicating that the flat electron and hole surfaces are substantially modified by the magnetic ordering. The implications of these results on the relation between the conduction electrons and the magnetic order in rare earth metals are discussed. Author

N67-36365# Brookhaven National Lab., Upton, N. Y.
HYPERFINE INTERACTION IN RARE EARTH METALS AND COMPOUNDS
G. Brunhart *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 495–505 refs Sponsored by AEC (See N67-36303 21-06)

Measurements were made on a series of rare earths, from Sm through Tm, using polarized neutrons and polarized targets, and values for the magnitude and sign of the hyperfine constants and effective fields were obtained. Author

N67-36366# Argonne National Lab., Ill.
TEMPERATURE DEPENDENCE OF THE HYPERFINE FIELD IN RARE EARTH-GOLD COMPOUNDS
B. D. Dunlap, A. E. Dwight, G. M. Kalvius, and C. W. Kimball *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 506–509 refs Sponsored by AEC (See N67-36303 21-06)

Ordered binary alloys of gold with various rare earths (Yb, Tm, Er, Ho) have been investigated by observing the Mössbauer hyperfine fields in Er^{166}, Tm^{169}, Yb^{171}, and Au^{197} nuclei. In these compounds the Au spectra are asymmetric doublets which are roughly independent of temperature. In some cases the rare-earth Mössbauer spectra show magnetic splittings and evidence of electronic relaxation effects. Author

N67-36367# Naval Ordnance Lab., White Oak, Md.
MAGNETOSTRICTION IN DILUTE RARE EARTH IRON GARNETS
A. E. Clark, J. J. Rhyne, and E. R. Callen *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 510–521 refs (See N67-36303 21-06)

The conventional single-ion theory of magnetoelastic coupling has successfully accounted for the temperature dependence of the huge magnetostriction observed in the heavy rare earth metals. It has also accounted for the temperature dependences in YIG and the high temperature behavior of the magnetostriction of Dy, Ho, and Er iron garnets. In this paper we have extended these measurements to low temperatures on GdIG and on a series of partially substituted $Dy_xY_{1-x}IG$ single crystals. We show that: (1) the magnetostriction is linear in Dy concentration, establishing a single-ion source, and (2) conventional statistical theory, which ignored crystal field effects, can be preserved for some magnetostrictive modes, but must be modified for others. Author

N67-36368# Argonne National Lab., Ill. Metallurgy Div.
ELASTIC MODULI OF Gd METAL
E. S. Fisher and D. Dever *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 522–533 refs Sponsored by AEC (See N67-36303 21-06)

The elastic moduli of Gd single crystals have been measured over the temperature range of 4° to 923°K. The results indicate that some degree of magnetic ordering exists between T_c and 330°K. A sharp transition is indicated at 286°K for compressional modes and 289°K for shear modes. It is suggested that a change in direction of the magnetic moments occurs abruptly at 218°K. The Debye θ calculated from the 4°K data is 181.5°K. This, together with the Debye θ calculated for Er ($\theta = 191$°K) suggests that the Debye θ of the trivalent rare earth metals are linearly related to the atomic weights. The anisotropy ratio, $A = c_{44}/c_{66}$, increases with temperature in the paramagnetic phase as expected for h.c.p. metals that transform to the b.c.c. structure at high temperatures. Author

N67-36371# Cincinnati Univ., Ohio. Dept. of Physics.
ON THE EXISTENCE OF AN ANTIFERROMAGNETIC PHASE IN RFe_7 COMPOUNDS
H. Weik, E. Susedik, and M. Turner *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 556–567 refs (See N67-36303 21-06)

Results of previous neutron diffraction studies on peritectic compounds of Pr and Nd with Fe of the type RFe_7 suggested the existence of an antiferromagnetic phase beyond the magnetically measured Curie temperatures. In order to prove or disprove this supposition, measurements of the specific heat and electric resistivity were performed with an arc-melted and homogenized Nd–Fe sample of the same composition and treatment as used in the neutron diffraction studies. The specific heat measurements, performed between room temperature and 110°C, exhibit a relative maximum at 56°C, in agreement with the magnetically determined Curie temperature of 53°C, and show with increased sample temperature a further increase, indicating a ferromagnetic–antiferromagnetic transition. Measurements of the electric resistivity are in agreement with this and seem to indicate a Néel temperature at about 300°C. The results are supporting newer magnetic measurements of other RFe_7 compounds in which signs of antiferromagnetism had been found. Author

N67-36373# Howard Univ., Washington, D. C. Dept. of Physics.
THE OPTICAL AND ELECTRICAL PROPERTIES OF YTTERBIUM THIN FILMS
Ogba A. Okorie and Sohan Singh *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 581–590 refs (See N67-36303 21-06)

In addition to reflectance and transmittance, the thickness and the resistivity of Yb thin films deposited by vacuum evaporation were measured in the spectral region 0.5 to 6.8 microns. From these data, the refractive index n, the extinction coefficient k, the absorption coefficient χ, the carrier density and the types of carriers as well as their relaxation time were calculated. Drude theory applied well between 1 to 3.5 microns. Hagen–Ruben's relation also applied at intervals. The infinite wavelength index of refraction is 10.9 while the indirect transition is 1.8 eV. The mean free path of the carriers is 236Å, the carrier velocity is 3.17×10^7 cm/sec, and the relaxation time is 7.45×10^{-14} sec. Empirically, the reflectance and the transmittance are related by an expression of the form $R = Ae^{-BT}$. Similar expression was determined for the reflectance and the wavelength. Author

N67-36374# Auburn Univ., Ala. Dept. of Physics.
ELECTRICAL CONDUCTION AND DIELECTRIC BREAKDOWN IN THIN EVAPORATED LAYERS OF SEVERAL RARE EARTH OXIDES
A. T. Fromhold, Jr., W. D. Foster, T. A. Harbuck, and R. B. Mosley *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 591–602 refs (See N67-36303 21-06)
(Contract NAS8-20061)

Some electrical measurements at 300°K are reported for thermally-evaporated oxides 300 to 6000 Å in thickness of the rare earth metals La, Ce, Pr, and Nd. Thin evaporated aluminum electrodes were utilized to impress voltages in the range zero to 80 volts across the oxide layers; electric fields as large as 5×10^6 volts/cm could be reached prior to destructive dielectric breakdown. Low field ($E \leq 10^4$ volts/cm) current–voltage characteristics are almost linear. High field ($E \geq 10^5$ volts/cm) current–voltage behavior is initially quite erratic, since the layers experience many nondestructive dielectric breakdowns. After voltage cycling, the current–voltage characteristics tend to become stable, reproducible, and nonlinear, with current densities ranging from one microampere/cm^2 to one ampere/cm^2. Author

N67-36375# Air Force Systems Command, Wright-Patterson AFB, Ohio. Materials Lab.
PERMANENT MAGNET PROPERTIES OF YCo_5 POWDERS
K. J. Strnat, J. C. Olson, and G. Hoffer *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 603–614 refs (See N67-36303 21-06)

The ferromagnetic intermetallic compounds of the type RCo_5 between several rare earths and cobalt were found to be promising candidates for a technological application as fine particle permanent magnets. The theoretical upper limits for the energy product of such magnets lie between 18 and 31.3 million Gauss–Oersted (28.1 MGOe for YCo_5), and coercive forces in excess of those of any other magnets may be expected. This paper describes experiments with powders of YCo_5 prepared by mechanical milling. Intrinsic coercivities up to ≈3000 Oe were achieved for particle sizes near 5μ, but further size reduction unexpectedly lowers H_c again. Author

N67-36376# Massachusetts Inst. of Tech., Cambridge. National Magnet Lab.
HIGH FIELD MAGNET MOMENT MEASUREMENTS IN SINGLE CRYSTAL RARE-EARTH METALS
S. Foner *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 615–617 refs Sponsored by AFOSR (See N67-36303 21-06)

Single crystals of Eu, Sm, and Tm were grown and examined in high magnetic fields. The Tm moment along the easy axis approaches that expected for saturation of the Tm^{+3} ion at high fields, and the low values of magnetic moment even at 70 kG can be attributed mainly to a very high anisotropy rather than to impurity effects. However the impurity effects may be the determining factor in the complex behavior presented earlier for Eu. Present data to 150 kG at 4.2°K show a constant susceptibility rather than a field dependent one in contrast to earlier low field polycrystalline data. The data for Sm shows a small susceptibility consistent with antiferromagnetic ordering. Pulse field studies up to about 400 kG were initiated. L.S.

N67-36377# Iowa State Univ. of Science and Technology, Ames. Inst. for Atomic Research.
FREQUENCY DEPENDENCE OF MAGNETIC LOSSES IN Ho IN THE NEIGHBORHOOD OF THE CURIE TEMPERATURE
B. C. Gerstein and F. Olander *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 618–626 refs Sponsored by AEC (See N67-36303 21-06)

The frequency dependence of the imaginary and real susceptibilities of polycrystalline Ho has been measured in the neighborhood of the ferromagnetic ordering temperature. For the

sample measured, the resonant frequency for domain wall motion lies below 22Hz indicating that ac susceptibilities of Ho measured above 10Hz will not agree with dc measurements. The results were fitted to a driven oscillator model and were found to correlate more closely with a model in which effective mass is ignored than with one in which it is not, but the agreement is not completely satisfactory. Author

N67-36378# Iowa State Univ. of Science and Technology, Ames. Inst. for Atomic Research.

ELECTRICAL RESISTIVITY AND SEEBECK EFFECT OF THULIUM SINGLE CRYSTALS

Sam Legvold and L. Roger Edwards *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 627–634 refs (See N67-36303 21-06)

Single crystals of Tm have been grown by the strain anneal technique. The electrical resistivity and the Seebeck coefficients have been measured along the three crystallographic directions as a function of temperature from 4° to 300°K. The electrical resistivity results indicate a Néel temperature of 57.5°K with no evidence for other magnetic transitions. The Seebeck coefficients also indicated a Néel temperature of 57.5°K. However, the Seebeck coefficient of the <0001> crystal showed a second transition at 32°K, which is in good agreement with low field magnetic susceptibility measurements on polycrystalline Tm. Neutron diffraction data of Koehler et al. indicated the transition to be about 38°K. Both measurements exhibited a significant anisotropy between the <0001> direction and the basal plane. Magnetic measurements on these samples are anticipated. Author

N67-36379# Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France).

ELECTRONIC STRUCTURE OF RARE EARTH CARBIDES [STRUCTURE ELECTRONIQUE DES MONOCARBURES DE TERRES RARES]

R. Lallement *In* Oak Ridge Natl. Lab. 6th Rare Earth Res. Conf. [1967] p 635–652 refs In FRENCH (See N67-36303 21-06)

Electric resistivity, thermoelectric power, magnetic susceptibility, and specific electronic heat were studied for rare earth carbides. A simple model for the band structure of these carbides is described that can be used for other rare earth compounds; and comparisons are made between these carbide structures and rare earth metals and compounds. Details of the electronic structure of monocarbides are included. Transl. by M.W.R.

N67-36433# California Univ., Berkeley. Lawrence Radiation Lab.

DETERMINATION OF WORK-FUNCTION DISTRIBUTION ON METAL SURFACES FROM SURFACE IONIZATION

Daniel R. Koenig Mar. 1967 5 p refs Presented at the 27th Ann. Conf. on Phys. Electron., Cambridge, Mass., 20–22 Mar. 1967

(Contract W-7405-ENG-48)

(UCRL-17437; CONF-670320-3) CFSTI: HC $3.00/MF $0.65

The fraction of an emitter surface occupied by patches having a given work function can be determined from the ion current–voltage characteristics of vapor diodes. The analysis assumes that emitted ions and atoms are in thermal equilibrium with the emitter surface, transport or space charge effects are negligible, the surface coverage of vapor particles on the emitter is always too small to alter its work function, and the ion emission from each patch is uninfluenced by the neighboring patches. A general expression for the emitter work-function distribution is derived in terms of the first and second derivatives (with respect to the applied voltage) of the observed ion current–voltage curve. Author (NSA)

N67-36436# California Univ., Berkeley. Lawrence Radiation Lab.

THERMAL PULSING OF METALS UNDER HIGH PRESSURE

Walter Alfred Stark, Jr. (Ph.D. Thesis) Apr. 1967 95 p refs

(Contract W-7405-ENG-48)

(UCRL-17454) CFSTI: HC $3.00/MF $0.65

The theory and instrumentation of a method for measuring the heat capacities of metals and semiconductors as functions of temperature and pressure in the Bridgman opposed-anvil apparatus are described. The technique involves measurement of the rate of temperature increase in the sample as electrical energy is added at a known rate for a short period of time. The method was used to follow the heat capacity anomaly near the Curie temperature T_c for Gd at pressures up to 20 kb; dT_c/dP was found to be -1.3°K/kb. The heat capacity of Fe was measured at 150 to 300°K for pressures between 20 and 100 kb; within the experimental uncertainty of 5 to 6% no variation of the heat capacity with pressure was observed in this interval. Some limitations of the present setup are discussed. A variation of the above technique using larger current pulses to thermally shock a metal under pressure was applied to the high pressure transformations of Bi, Sn, and Fe. This method appears to yield thermodynamic values of transition pressures and the following fixed points were obtained: Bi, 81 ± 4 kb; Sn, 99 ± 4 kb; and Fe, 118 ± 6 kb. The dependence of the electrical resistance of Fe on the three-halves power of the absolute temperature at pressures greater than 20 kb was noted. Author (NSA)

N67-36472*# Illinois Univ., Urbana. Dept. of Physics.

APPLICATION OF THE AUGER PROCESS TO THE STUDY OF GASEOUS ADSORPTION ON TUNGSTEN

Gary George Tibbetts (Ph.D. Thesis) Aug. 1967 137 p refs

(Grant NsG-376; Contract DA-28-043-AMC-00073(E))

(NASA-CR-88362; R-363) CFSTI: HC $3.00/MF $0.65 CSCL 20L

Absorption of gas on tungsten was studied at room temperature, and at liquid nitrogen temperature by the flash filament and Auger techniques. The apparatus is described which allows the density of gas adsorbed on metal surfaces to be monitored by observing changes in the number of electrons ejected from the surface by a constant-current, low-energy ion beam. It is shown that the electron emission process, an Auger process, is temperature independent; thus, surface coverages may be easily compared at different temperatures. Tungsten (110) does not adsorb nitrogen until it is cooled to liquid nitrogen temperatures when N_2 adsorbs in a state of unique binding energy of .61 eV. This state desorbs with first order kinetics. The Auger desorption spectrometry technique gives promise of being useful in surface investigations. R.L.I.

N67-36507*# Westinghouse Electric Corp., Baltimore, Md. Defense and Space Center.

RESEARCH AND DEVELOPMENT ON AN ELECTRON-SENSITIVE SOLID STATE MATRIX Final Report

Washington, NASA, Sep. 1967 121 p refs

(Contract NAS5-3446)

(NASA-CR-866) CFSTI: HC $3.00/MF $0.65 CSCL 09A

A study to show feasibility of an electron-sensitive solid state matrix. This matrix was to detect electrons with energies between 20 and 50 keV, and in addition, it was to determine the lateral position at which these electrons hit the matrix. A variety of composite surface barrier diodes were made and tested. The front surface of these diodes consisted of a p-type inversion layer on high resistivity n-type silicon. The insensitive side (the back) of these units had a grid-like arrangement of contacts on them with up to 32 lines running in each of the two perpendicular directions. The horizontal and vertical sets of these lines were insulated from each other. The units having 32 lines per 1/2 inch on their insensitive side were tested with a radioactive source and with an electron-beam setup built for this purpose. It was found that the

area above some lines was extremely sensitive to 35 keV electrons and that some of these lines were completely noiseless. An electronic tube was constructed with one of the surface barrier units in it. This tube has an S-11 (cesium-antimony) photocathode in it and the electrons emitted from this layer then are focused and accelerated toward the anode. After over 1 month of operation, the tube was still working with an output level of about 30 percent of its original yield for a specified amount of incident ultraviolet and visible light intensity. Author

N67-36520* National Aeronautics and Space Administration, Washington, D. C.
QUANTUM THEORY OF THERMOGALVANOMAGNETIC PHENOMENA IN METALS AND SEMICONDUCTORS, PART II [K KVANTOVOY TEORII TERMOGAL'VANOMAGNITNYKH YAVLENIY V METALLAKH I POLUPROVODNIKAKH (II)]
P. S. Zyryanov Aug. 1967 9 p refs Transl. into ENGLISH from Phys. Status Solidi (USSR), v. 7, 1964 p 223–230
(NASA-TT-F-11154) CSCL 20L

In a quantized magnetic field the space-densities of heat flux and conductivity curfent due to the inelastic scattering of electrons by phonons are found. These values are necessary for the construction of a quantum theory of thermogalvanomagnetic phenomena in metals and semiconductors. A single method for calculating the space densities of heat flux and conductivity current is proposed. Author

N67-36535*# Scientific Translation Service, La Canada, Calif.
SOME PROPERTIES OF THE PYROLYTIC CARBIDES AND NITRIDES OF GROUP IV METALS [NEKOTORYYE SVOYSTVA PIROLITICHESKIKH KARBIDOV I NITRIDOV METALLOV IV GRUPPY]
V. S. Neshpor, V. A. Davydov, B. G. Yermakov, and B. B. Mollievich Washington, NASA, Aug. 1967 8 p refs Transl. into ENGLISH from Poroshkovaya Met., Akad. Nauk Ukr. SSR (Kiev), v. 7, no. 2, 1967 p 65–69
(Contract NASw-1496)
(NASA-TT-F-11180) CSCL 20L

Measurement of the specific electrical resistance, microhardness, specific thermal conductivity, absolute differential thermal emf, the Hall coefficients, and thermal expansion and elongation for TiC, ZrC, HfC, TiN, ZrN, and HfN and some NC-compounds of these metals. The behavior of these characteristics agrees well with theoretical considerations concerning the electron structure of these pyrolytic compounds. Author

N67-36553* National Aeronautics and Space Administration, Washington, D. C.
CONTRIBUTION TO THE QUANTUM THEORY OF THERMOGALVANOMAGNETIC PHENOMENA IN METALS AND SEMICONDUCTORS, PART I [K. KVANTOVOY TEORII TERMOGAL'VANOMAGNITNYKH YAVLENIY V METALLAKH I POLUPROVODNIKAKH (I)]
P. S. Zyryanov Aug. 1967 9 p refs Transl. into ENGLISH from Phys. Status Solidi, (USSR), v. 6, 1964 p 401–408
(NASA-TT-F-11155) CSCL 20L

Formulas are obtained for the nondissipative densities of heat and electric currants in the high-magnetic-field quantum limit, taking account of electron-spin. In the elastic scattering approximation, expressions are also found for the dissipative densities of heat and electric currents. The results so obtained permit calculation of any thermogalvanomagnetic effect in the high magnetic field quantum limit $\Omega\tau >> 1$ (Ω being the cyclotron resonance frequency and τ the relaxation time). Author

N67-36571# Massachusetts Inst. of Tech., Cambridge.
RESEARCH IN MATERIALS SCIENCE AND ENGINEERING Annual Report, 1966–1967
Apr. 1967 441 p refs
(Contracts ARPA-SD-90; DA-19-020-AMC-0231(X); DA-19-020-ORD-5443(X); DA-19-129-AMC-238(N); DA-28-043-AMC-01978(E) et al)
(AD-652583)

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N67-36572# Massachusetts Inst. of Tech., Cambridge.
CHEMICAL AND SOLID STATE PHYSICS
In its Res. in Mater. Sci. and Eng. Apr. 1967 p 1–62 refs (See N67-36571 21-26)

Studies are reported on solid state and molecular theory; structure of solids as determined by X-ray, neutron, and electron diffraction; low temperature physics and thermal properties; optical, microwave, and radio frequency physics; and interatomic and intermolecular forces. Diffraction studies deal with crystal and surface structure investigations, X-ray determinations of imperfections in real structures, and neutron diffraction and neutron physics research. Ultrasonic investigations and infrared spectroscopy of order–order phenomena are reported. Other researches deal with molecular spectroscopy, infrared and Raman spectroscopy of solids, semiconductors and infrared spectroscopy, microwave spectroscopy, and optical and infrared masers. Brillouin scattering in liquids and solids, as well as nuclear magnetic resonance and light scattering in magnetic storms are discussed. M.W.R.

N67-36573# Massachusetts Inst. of Tech., Cambridge.
ELECTRIC, MAGNETIC, AND OPTICAL PROPERTIES OF MATERIALS AND APPLICATIONS TO DEVICES
In its Res. in Mater. Sci. and Eng. Apr. 1967 p 63–120 refs (See N67-36571 21-26)

Reports are presented on materials theory, semiconductor materials and devices, thin film devices, and microwave and quantum magnetics. Efforts of the crystal physics and particle optics laboratories are summarized in this section dealing with electric, magnetic, and optical properties of materials and device applications. M.W.R.

N67-36574# Massachusetts Inst. of Tech., Cambridge.
METALLURGY AND MATERIALS SCIENCE
In its Res. in Mater. Sci. and Eng. Apr. 1967 p 121–241 refs (See N67-36571 21-26)

Physics of solids studies are reported, along with various efforts relating to physical metallurgy. The latter includes researches on phase transformations, structure–property relationships, deformations, strengthening mechanisms, radiation damage, condensation in nozzles, and thermodynamics of metallic systems. Other reviews deal with high temperature metallurgy, surface chemistry, and metals processing. Developments in ceramics, polymers, electronic materials, and superconductors are reported; as are efforts in mineral engineering, and by the X-ray and electron optics laboratory and the corrosion laboratory. M.W.R.

N67-36576# Massachusetts Inst. of Tech., Cambridge.
NATIONAL MAGNET LABORATORY
In its Res. in Mater. Sci. and Eng. Apr. 1967 p 311–356 refs
(See N67-36571 21-26)

High field magnet development, magneto-optical studies, optical effects, and cyclotron resonance studies are summarized. Other studies deal with magnetic measurements relating to semiconductors, various alloys and metals, and ferromagnetism. Transition metals and their ion complexes, Mössbauer effect, crystal field splitting, instability in superconducting magnets, and new instrumentation are among the other research efforts of the National Magnet Laboratory described in this section. M.W.R.

N67-36578# Massachusetts Inst. of Tech., Cambridge.
LINCOLN LABORATORY
In its Res. in Mater. Sci. and Eng. Apr. 1967 p 375–398 refs
(See N67-36571 21-26)

Solid state theory and physics research at the Lincoln Laboratory is reported, along with applied physics investigations dealing with laser emission and electron beam excitation. Optics and infrared studies and electronic materials development are also summarized. M.W.R.

N67-36654# General Dynamics Corp., San Diego, Calif. General Atomic Div.
LATTICE PHYSICS STUDIES Quarterly Progress Report, Period Ending Mar. 31, 1967
G. D. Trimble, T. Gozani, J. M. Neill, V. Orphan, and C. A. Preskitt
11 Apr. 1967 85 p refs
(Contract AT(04-3)-167)
(GA-7934; EURAEC-1840) CFSTI: HC $3.00/MF $0.65

A facility for measurement of neutron spectra in tightly packed lattices was performance-tested. Foil activation analyses and time-of-flight spectral measurements were made in erbium nitrate. k_{eff} and dieaway time for the first experimental lattice was calculated. The possible use of a pressure vessel for elevated temperature measurements was evaluated. NSA

N67-36662# Technische Hochschule München (West Germany). Fakultaet fuer Allgemeine Wissenschaften.
REACTION KINETICS ANALYSIS OF RECOVERY FROM POINT DEFECTS. MEASUREMENTS ON PLATINUM [REAKTIONSKINETISCHE ANALYSE DER ERHOLUNG VON PUNKTFEHLERN. MESSUNGEN AN PLATIN]
Klaus Kinkeldei (Ph.D. Thesis) 1966 99 p refs In GERMAN

Recovery behavior was studied on platinum wire samples cold-drawn at −68°C and 20°C. Stress deformation of V=2.01 and V=1.735 were attained. The recovery behavior was determined by measuring the electric resistance following the thermal treatment. Isochronous or isothermal thermal treatment was given to identical samples. Three levels of recovery were observed for electric resistance in the temperature range from −40°C to 500°C. Model calculations for isochronous normalization were used to establish the accuracy of the method for evaluating activation enthalpy and reaction kinetics. The values obtained for the activation enthalpy can be used to perform a reaction-kinetic analysis for each level of recovery. Transl. by K.W.

27 PROPELLANTS

Includes fuels; igniters; and oxidizers. For basic research see: 06 Chemistry; and 33 Thermodynamics and Combustion. For related information see also: 28 Propulsion Systems.

N67-35368*# Pratt and Whitney Aircraft, West Palm Beach, Fla. Research and Development Center.
INVESTIGATION OF LIGHT HYDROCARBON FUELS WITH FLUORINE–OXYGEN MIXTURES AS LIQUID ROCKET PROPELLANTS Final Report, 22 Jun. 1965–15 Jun. 1967
J. C. Matheson et al 15 Sep. 1967 149 p refs
(Contract NAS3-6296)
(NASA-CR-72147; PWA-FR-2227) CSCL 21I

Performance and cooling analyses were made to determine the highest performing light hydrocarbon fuels for use with flox in regeneratively cooled and transpiration cooled pressure-fed thrust chambers. Sea level and simulated-altitude rocket firings were made at nominal 100-psia chamber pressure and 5000-lb vacuum thrust in uncooled, transpiration cooled, and regeneratively cooled chambers using flox with methane, propane, and butene-1. Based on the data obtained in these tests, predicted performance was calculated for these propellants over a range of thrust levels. Author

N67-35642*# Union Carbide Corp., Bound Brook, N. J.
SATURATED HYDROCARBON POLYMERIC BINDER FOR ADVANCED SOLID PROPELLANT AND HYBRID SOLID GRAIN Quarterly Report, Feb. 1–Apr. 30, 1967
James E. Potts, ed. 19 May 1967 34 p refs Prepared for JPL
(Contracts NAS7-100; JPL-951210)
(NASA-CR-88018; QR-6) CSCL 21I

Several chain transfer agents are being investigated as to their suitability for placing desirable functional groups at the ends of ethylene–neohexene copolymer chains. Symmetrical disulfides, such as dimethyl dithioglycolate were not very effective as telogens for ethylene/neohexene copolymers. Much more promising results have been obtained with telogens containing the carbon–halogen bond. Carbon tetrachloride gave telomers containing –Cl and $-CCl_3$ as polymer end groups. Conversion of these groups to –COOH has proven to be unexpectedly difficult. Telomers have been obtained from each of these telogens, and the analytical data thus far received are quite favorable. In particular, the first BBIB telomer analysed contains .95 ester groups and .84 bromine atoms per molecule. Model compound studies on 11-bromohendecanoic acid have demonstrated the feasibility of this approach for preparing dicarboxylic acids. Author

N67-35988*# Martin Co., Denver, Colo.
STERILIZABLE LIQUID PROPULSION SYSTEM Quarterly Progress Report, 2 Jan.–31 Mar. 1967
H. F. Brady and C. Holt Apr. 1967 81 p Prepared for JPL
(Contracts NAS7-100; JPL-951709)
(NASA-CR-88020; QPR-2; MCR-67-15) CFSTI: HC $3.00/MF $0.65 CSCL 21H

The basic design system was established and detailed structural design work was begun to determine the feasibility of exposing a loaded bipropellant propulsion system to ethylene oxide and heat sterilization environments without experiencing system degradation. Extensive data are presented concerning analysis and selection of individual system components from those submitted by various suppliers. A rocket engine, which is compatible with the defined sterilization requirements, was selected. Suggested alloys for propulsion system hardware fabrication are specified. The 600-hour material screening tests were completed and results revealed that: (1) the large surface area of screens render them far more susceptible to attack than sheet metal; and (2) fine screens and foils must be given special handling during construction and fabrication. Descriptions of program test facilities and equipment, and results of materials compatibility tests are also presented. E.C.

28 PROPULSION SYSTEMS

Includes air breathing, electric, liquid, solid, and magneto-hydrodynamic propulsion. For nuclear propulsion see: 22 Nuclear Engineering. For basic research see: 23 Physics, General; and 33 Thermodynamics and Combustion. For applications see: 31 Space Vehicles. For related information see also: 27 Propellants.

N67-35446*# Electro-Optical Systems, Inc., Pasadena, Calif.
DIAGNOSTIC MEASUREMENTS IN ALPHA (ALKALI PLASMA HALL ACCELERATOR) Final Report, 22 Feb.–17 May 1967
P. F. Jacobs, G. L. Cann, and R. L. Harder 31 May 1967 173 p refs
(Contract NAS3-8902)
(NASA-CR-72233; EOS-7053-Final) CSCL 21C

Presented are results of a study of the Alkali Plasma Hall Accelerator (ALPHA). Reported are studies in three areas. The first entailed the design, fabrication, checkout, and parametric performance testing of the ALPHA engine. Extensive measurements of electrical power input, thrust, propellant mass flow, thermal efficiency, thrust efficiency, specific impulse, magnet power, power losses to the cathode, buffer, anode and magnet housings, over-all efficiency, and the background tank pressure are presented. The second and major area of study involved a detailed series of diagnostic experiments designed to improve the confidence of performance test results, and to further knowledge of the basic physics involved in the ALPHA device. Diagnostic experiments included measurements of the plasma axial velocity using Doppler effect spectroscopy and a phototracer technique based upon optical time-of-flight determinations. Other diagnostic measurements which are presented include the distribution of the axial, radial, and azimuthal components of the magnetic field; spectroscopic evidence of the existence of plasma rotation; mass flux distributions, and the magnitude and characteristic frequencies of the emf induced by a magnetic loop probe. The final area of study involved an analytical study of a concept of an effective mass flow rate for deriving a set of relations for the discharge voltage in the regimes of mass flow rate which were higher or lower than the effective mass flow rate. S.C.W.

N67-35525*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
ELECTROTHERMAL MICROTHRUST SYSTEMS
Arthur F. White Aug. 1967 10 p refs Presented at AIAA 3rd Propulsion Joint Specialist Conf., Washington, D. C., 17–21 Jul. 1967
(NASA-TM-X-55897; X-734-67-387) CFSTI: HC $3.00/MF $0.65 CSCL 21C

A limited treatment of design and performance characteristics of several electrothermal microthrust systems is presented. Two systems described have been incorporated into spacecraft. The spacecraft functions for which they are being used or contemplated for use are attitude control, station keeping, and station seeking. Heated ammonia fast heat-up systems are proposed for station keeping of the synchronous orbit, gravity gradient stabilized spacecraft (D and E) in the Applications Technology Satellite series. Experimental versions being flown earlier are described. Single jet and multijet thermal storage thrusters for systems application are currently in an advanced stage of development. Design configuration and curves of specific impulse and temperature versus power are shown. These units have thrust levels ranging from 5 to 50 millipounds at specific impulses greater than 240 seconds. The multijet thrusters incorporate as many as five exit nozzles. Tables of performance data show current development status of these units. Author

N67-35731* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
COMPUTER PROGRAM FOR DETERMINING EFFECTS OF CHEMICAL KINETICS ON EXHAUST-NOZZLE PERFORMANCE
Leo C. Franciscus and Jeanne A. Healy Washington, NASA, Sep. 1967 106 p refs
(NASA-TN-D-4144) CFSTI: $3.00 CSCL 21H

A computer program is described that can be used to compute nozzle performance, including chemical kinetic losses in the nozzle for rockets and subsonic or supersonic combustion ramjets. The kinetic analysis is designed for any chemical system in which the change in molecular weight is due to the three-body recombination reactions only and one in which the energy exchange through the bimolecular reactions is small in comparison with that of the other reactions. The analysis makes use of Bray's sudden freezing criterion to determine a freezing point in the nozzle. The engine performance is then determined by assuming that the composition of the exhaust gas remains unchanged or frozen from the freezing point to the nozzle exit. The program can also be used for equilibrium and frozen or specified freezing point calculations for any rocket propellant system or ramjet fuel. Author

N67-35762# ARO, Inc., Arnold Air Force Station, Tenn.
ALTITUDE EVALUATION OF THE INTELSAT II COMMUNICATIONS SPACECRAFT APOGEE MOTOR IN THE SPIN MODE AT AN ENVIRONMENTAL TEMPERATURE OF 55°F
A. A. Cimino and C. W. Stevenson Arnold Eng. Develop. Center, Jun. 1967 46 p refs
(Contract AF 40(600)-1200)
(AEDC-TR-67-43; AD-654269) CFSTI: HC $3.00/MF $0.65

An Aerojet-General Corporation SVM-1 solid-propellant apogee rocket motor installed in an INTELSAT II communications spacecraft (S/N T-1) was fired, while spinning at 120 rpm, at a pressure altitude of 108,000 ft. The primary objective of the program was verification of vacuum performance of the apogee motor after a 75-hr exposure of the motor to a 55 plus or minus 5 F temperature and a near-vaccum conditioning environment. Secondary objectives were to evaluate the control and performance of a strip heater attached to the nozzle flange, to check the structural integrity of a thermal shield on the motor aft dome, and to determine the existence of any significant dynamic coupling between the motor and the spacecraft. Motor performance is presented and compared with data from earlier firings of the same type of motor.

Temperature-time histories at selected locations on the motor and spacecraft are also presented. Performance of the nozzle flange strip heaters, the structural integrity of the thermal shield, and vibration data are also discussed. Author (TAB)

N67-35774*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

EXPERIMENTAL EVALUATION OF SIX ABLATIVE-MATERIAL THRUST CHAMBERS AS COMPONENTS OF STORABLE-PROPELLANT ROCKET ENGINES

Arthur M. Shinn, Jr. Washington, NASA, Jun. 1967 43 p refs (NASA-TN-D-3945) CFSTI: $3.00 CSCL 21H

Nitrogen tetroxide N_2O_4 and a 50–50 blend of unsymmetrical dimethyl hydrazine with hydrazine N_2H_4 were used in the tests. Initial nozzle throat diameters were 7.82 in. Engines were operated at a constant chamber pressure of 100 psia and an oxidant-to-fuel ratio of 2.0. The six thrust chambers provided both material and geometry variables. A material of high-purity silica-cloth reinforcement and phenolic resin had greater throat erosion resistance than a similar combination with an elastomer additive or one of graphite-cloth reinforcement and phenolic resin. High-silica-cloth reinforcement used with the fibers oriented 60° downstream relative to the engine centerline had greater throat erosion resistance than molded 1/2-inch squares. An ablative-material chamber section with a 7.66° half-angle of contraction and a tubular throat provided better throat erosion resistance than one of similar material with a 15° half-angle and a contoured throat. A full-length ablative material chamber had better throat erosion resistance than one of equal overall length but with a water-cooled section ahead of the ablative material chamber for runs longer than 470 sec. However, the shorter ablative section exhibited a negative area change for the first 410 sec. K.W.

N67-35991# Army Aviation Material Labs., Fort Eustis, Va.

INVESTIGATION OF THE FEASIBILITY OF BURNING EMULSIFIED FUEL IN GAS TURBINE ENGINES

Mar. 1967 210 p refs

(USAAVLABS-TR-67-24; AD-654816)

A discussion is presented of the results of five different gas turbine engines operating on emulsified JP-4 fuel. Problems associated with using emulsified fuel, and the conclusions and recommendations as they pertain to each individual engine, are given. The results of these studies indicate that it is feasible to operate a gas burbine engine on emulsified JP-4 fuel, several areas in which further research is needed, as recognized by the engine companies, are brought out. Author (TAB)

N67-36056# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.

EXTERNAL BURNING RAMJETS PRELIMINARY FEASIBILITY STUDY

G. L. Dugger and L. Monchick Mar. 1967 93 p refs

(Contract NOw-62-0604-c)

(TG-892; AD-655459) CFSTI: HC $3.00/MF $0.65

Experiments and analyses have shown that burning beneath external surfaces of a supersonic vehicle can produce lift and reduce drag. Preliminary analyses of some two-dimensional external burning ramjet (ERJ) and external expansion ramjet (EERJ) models yield some encouraging results. The EERJ uses ducted subsonic combustion but all-external expansion, so that the two-dimensional (or half-round) nozzle obtains some heat relief by radiation and contributes to vehicle lift, increasing lift/drag ratio. Effects of vectoring the EERJ nozzle and advantages and disadvantages of substituting a simple ramp in place of the nonreflecting surface are explored briefly. Three possible paths for the design of hypersonic transport vehicles incorporating EERJ's for cruise power and auxiliary lower speed engines are pictured and discussed in general terms. Author (TAB)

N67-36105 Man-Turbomotoren G.m.b.H., Munich (West Germany).

THE CRYOGEN TWO-PHASE ROCKET TRANSMISSION AND ITS APPLICATION POSSIBILITIES IN SPACE AVIATION TECHNOLOGY [DAS KRYOGENE ZWEIPHASEN-RAKETEN-TRIEBWERK UND SEINE ANWENDUNGSMOEGLICHKEITEN IN DER RAUMFAHRTTECHNIK]

M. Simon 21 Mar. 1967 49 p refs In GERMAN Presented at the DGRR Symp. on Chem. Rocket Propulsion

CFSTI: HC $3.00/MF $0.65

A universal propulsion concept is outlined which permits operation of a cryogenic–liquid/oxidizer engine system with any choice of a liquid–liquid, liquid–gas, or gas–gas propellant phase. Phase combinations are demonstrated for the operation of an F_2/H_2 engine, and it is shown that thrust losses during phase start-up can be kept within acceptable limits. Application of these two-phase rocket engines in cryogenic spacecraft is discussed. An example is given of a Jupiter satellite using the two-phase system with high-energy cryogenic propellant combinations on an optimized interplanetary mission. Applied to the ELDO B 1/2 launch vehicle used for a 24-hour synchronous trajectory, the system results in weight savings of approximately 70% for the B 1 and 15% for the B 2 carrier. Briefly described is also the development of a 500-kp $H_2/O_2/F_2$ two-phase engine. Transl. by K.W.

N67-36430# Thiokol Chemical Corp., Elkton, Md.

PHYSICAL AND BALLISTIC TESTS IN SUPPORT OF SOUNDING ROCKET VEHICLES Final Report, Mar. 1964–Feb. 1967

John W. Edwards and John Mallick May 1967 71 p refs

(Contract AF 19(628)-4068)

(E57-67; AFCRL-67-0275; AD-654746)

A series of tests was conducted on the TE-M-388 Iroquois motor to determine ending characteristics and to investigate the effect of resonance, low temperature, and spin on the performance of the TE-M-388 motor. Tests were also conducted on the Apache and Cajun motors to determine if unstable burning could be induced. The test results show the performance capability of the TE-M-388 motor under all conditions described above and show that unstable burning could not be triggered on the Apache and Cajun motors under the conditions tested for. Author (TAB)

N67-36471* Farnham (Frank C.) Co., Philadelphia, Pa.

SIMPLIFIED METHOD OF MEASUREMENT OF TEMPERATURE FIELDS BEHIND THE COMBUSTION CHAMBERS OF TURBOJET ENGINES [ZJEDNODUSENA METODA MERENI TEPLOTNICH POLI ZA SPALOVACIMI KOMORAMI PROUDOVYCH MOTORU]

Oldrich Schurek Washington, NASA, Aug. 1967 22 p refs Transl. into ENGLISH from Zpravod. Vyzkumny a Zkusebni Letecky Ustav (Letnany), no. 3 1966 p 88–100

(Contract NASw-1497)

(NASA-TT-F-11111) CSCL 21E

Analysis of the measurements of temperature profiles along a turbine blade, using results of measurements made by the author as well as those found in the literature. The temperature profile along the height of a turbine blade in an annular combustion chamber with jet atomization of fuel was compared with that of a rotating disk with combustion chambers of mixed and combined design. The temperature profile was investigated on combustion chambers, and the testing was completed under laboratory conditions; the chambers were adapted for operation with turbojet engines. The influence of the excess air coefficient, air inlet pressure and temperature, geometric layout of the combustion chamber, and turbine blade height was investigated. Author

N67-36673# Royal Aircraft Establishment, Farnborough (England).
MICROTHRUST PROPULSION I
B. P. Day *In* ESRO Control and Stabilization of Spacecraft. Vol. III: Active Control Systems Jan. 1967 p 89–108 (See N67-36669 21-31)

Mass-ejection systems for attitude and orbit control of satellites are being developed in the microthrust range (less than 5 newtons). Acceleration of the propellant may be achieved either by thermodynamic or electromagnetic means. The first method involves the expansion of a gas through a venturi nozzle; the governing equations are quoted. There are two types of systems, cold gas and hot gas, which are described in some detail. This method becomes prohibitive as the required life of the satellite increases, and a considerable amount of research has therefore been carried out on generating thrust by electromagnetic acceleration. This can be done by means of ion jets or plasma jets; the different types of each are described. Author (ESRO)

N67-36674# Royal Aircraft Establishment, Farnborough (England).
MICROTHRUST PROPULSION II
B. P. Day *In* ESRO Control and Stabilization of Spacecraft. Vol. III: Active Control Systems Jan. 1967 p 109–127 refs (See N67-36669 21-31)

Details are given on the design of cold gas systems. The two main systems, nitrogen and propane, are considered together. The individual components treated comprise storage tanks, boilers (for propane systems), pressure controllers, nozzles, and control valves. Matching of control valve and nozzle is gone into in some detail. Suggestions that propane may have harmful effects on some satellite-borne experiments are examined, and it is concluded that they are unfounded. Author (ESRO)

29 SPACE RADIATION

Includes cosmic radiation; solar flares; solar radiation; and Van Allen radiation belts. For related information see also: 13 Geophysics; and 24 Physics, Atomic, Molecular, and Nuclear.

N67-35402# Pomona Coll., Claremont, Calif. Dept. of Physics.
X-RAY ABSORPTION IN THE 2-TO-200 A REGION
B. L. Henke, R. L. Elgin, R. E. Lent, and R. B. Ledingham Jun. 1967 39 p refs
(Grant AF-AFOSR-689-64)
(AFOSR-67-1254; AD-654315)

Physical and chemical analysis, x-ray astronomy and high temperature plasma diagnostics which utilize the ultrasoft x-radiations have made evident a strong need for filling the gap in measured absorption coefficient data for the radiations between the conventional x-rays and the extreme ultraviolet. More than one hundred new coefficients have been recently measured in this laboratory on the gas state, atomic or molecular, containing He, C, N, O, F, Ne, S, Cl, Ar, Kr, and Xe using eleven fluorescent characteristic wavelengths Al-K (8.34 A) through Be-K (113.8 A). The radiations were isolated by Bragg reflection from multilayer analyzers of the Langmuir-Blodgett type and by pulse height discriminating proportional counter intensity measurements. Using these data and data previously published, a complete table has been determined for He through Ar and for wavelengths below the L sub III edges and in the region 2-to-200 A. Absorption cross sections have been calculated for many compound materials which are commonly encountered in low energy x-ray analysis. The transmission of x-rays from a source above the earth has been tabulated as a function of altitude and wavelength. Author (TAB)

N67-35455# California Univ., Livermore. Lawrence Radiation Lab.
ADIABATIC CALORIMETRIC MEASUREMENTS OF X-RAY INTENSITY
Grover M. Taylor 4 Apr. 1967 7 p
(Contract W-7405-ENG-48)
(UCID-15126) CFSTI: HC $3.00/MF $0.65

A method for measuring x-ray intensity by adiabatic colorimetric measurements is described. The theoretical aspects, equipment used, and performance of the method itself are discussed. NSA

N67-35608 Observatoire de Paris (France). Section d'Astrophysique, a Meudon.
SYNOPTIC CHARTS OF THE SOLAR CHROMOSPHERE AND LISTS OF THE FILAMENTS AND CENTERS OF ACTIVITY, VOLUME IV [CARTES SYNOPTIQUES DE LA CHROMOSPHERE SOLAIRE ET CATALOGUES DES FILAMENTS ET DES CENTRES D'ACTIVITE, FASCICULE IV]
M. J. Martres 1966 76 p In FRENCH Sponsored by UNESCO

For the period 3 January 1964 to 13 December 1965, 26 synoptic charts of astrophysical observations are presented. They are accompanied by tables which group the data on filaments and centers of activity observed during this period. There has been no change in the conventions selected to represent the phenomena and the meaning of the abbreviations remains the same. Tabulated data include rotation, average coordinates, heights, and specification as to partial or total visibility of observations. Transl. by R.Ll.

N67-35701# Lowell Technological Inst. Research Foundation, Mass.
STUDY OF ABSORPTION AND REFRACTION CHANGES IN RADIATION EMANATING FROM JUPITER AND RADIO STARS Final Report, Oct. 1961–Sep. 1966
C. L. Bennett, Jr., K. Bibl, D. N. Gaunt, and B. W. Reinisch Feb. 1967 75 p refs
(Contract AF 19(628)-234)
(LTIRF-263/IP; AFCRL-67-0114; AD-654689)

An interferometric riometer system with a swept frequency range of 19 to 41 MHz operates at the Air Force Cambridge Research Laboratories Sagamore Hill Observatory. Matching of the system to its functional principle required basic modifications in the operating period from October 1961 to September 1966. Several published papers resulted from a study of the events recorded during observation of the planet Jupiter. Abstracts of the papers appear here with a catalog of supporting data. Other observations include: special events from the Sun and Cassiopeia, as well as a solar eclipse. New techniques, resulting from experience gained by operation of this equipment, led to a proposal for an improved system. Author (TAB)

N67-35866*# State Univ. of Iowa, Iowa City. Dept. of Physics and Astronomy.
DIFFUSION OF SOLAR COSMIC RAYS AND THE POWER SPECTRUM OF THE INTERPLANETARY MAGNETIC FIELD
K. V. S. K. Nathan and J. A. Van Allen Aug. 1967 8 p refs
(Grant NsG-233-62)
(NASA-CR-88208; Rept.-67-43) CFSTI: HC $3.00/MF $0.65
CSCL 20H

Van Allen and Krimigis [1965] find that solar electrons diffuse through the interplanetary medium at a rate which is similar to that of protons of the same velocity, despite the disparity by a factor of 2×10^3 in their respective magnetic rigidities, and they suggest that this fact serves to extend knowledge of the structure of the interplanetary magnetic field to much smaller scale than has been measured [Coleman, 1966]. This suggestion is developed quantitatively in the framework of Roelof's [1965] theory. It is found that the power spectrum of the interplanetary magnetic field varies inversely as the square of the frequency f in the range $2.7\times10^{-4}<f<0.5$ cps. Author

N67-36084# Library of Congress, Washington, D. C. Aerospace Technology Div.
SOLAR FLARE PATROL AND PREDICTION
Daniel W. Michaels 22 Aug. 1967 40 p refs *Its* Work Assignment 101
(ATD-67-34)

The solar services organizational setup is described. Achievements and developments in solar flare investigations and patrol station operations are reviewed. Listings are given of solar observation sites with selected instrumentation data and a general breakdown of capabilities in such areas as: chromospheric, coronal, and cosmic ray observations; and studies of solar radio emissions. Techniques for predicting solar flare activity are also considered. A small amount of abstracts based on pertinent technical reports are included. E.C.

N67-36120*# State Univ. of Iowa, Iowa City. Dept. of Physics and Astronomy.
GEOMAGNETICALLY TRAPPED ALPHA PARTICLES
S. M. Krimigis and J. A. Van Allen Jul. 1967 70 p refs
(Contract NAS1-2973; Grant NsG-233-62; Contract Nonr-1509(06))
(NASA-CR-88361; Rept.-67-29) CFSTI: HC $3.00/MF $0.65 CSCL 04A

Observations were made with the Injun IV satellite which was launched on 21 November 1964 into a nearly polar orbit of 81° inclination with initial apogee and perigee altitudes of 2502 and 527 kilometers, respectively. It carried a 25 micron thick, totally depleted silicon surface barrier detector with four electronic descrimination levels. Available data up to 17 April 1965 are summarized and conclusions are presented. Author

N67-36166# Norwegian Defence Research Establishment, Kjeller.
TOTAL ELECTRON CONTENT MEASUREMENTS AT HIGH LATITUDES Final Scientific Report, 1 Jan. 1965–31 Oct. 1966
J. Frihagen and O. M. Bratteng 15 Jan. 1967 29 p refs
(Contract AF 61(052)-860)
(E-101; AFCRL-67-0356; AD-654330)

The differential frequency Faraday technique has been applied to recordings, from three high latitude stations, of the 40 and 41 MHz transmission from the polar ionospheric beacon satellite S66 (BE-B) to obtain total ionospheric electron content. Results of the measurements are presented for the latitude range from 50 degrees N to 80 degrees N. The data is not sufficient to distinguish properly between diurnal and seasonal variations in electron content. The mean latitudinal variation gives a steady decrease of electron content with increasing latitude from 50 degrees to 60 degrees, a minimum in winter night between 60 degrees and 70 degrees, and an increase towards north, in night and early morning in winter, above 70 degrees. It is suggested that this anomalous variation may be explained by a phase shift of the dirunal variation at high latitudes compared to low. The electron content does not show a systematic dependence on magnetic K index. The equivalent slab thickness at 60 degrees and 70 degrees shows a seasonal and diurnal variation with a maximum in summer and at midday. The diurnal variation is most pronounced in winter. The slab thickness shows a slight increase with increasing K index. Author (TAB)

N67-36422*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THE ELECTROMAGNETIC RADIATION ASSOCIATED WITH THE ENERGY DISSIPATED BY COSMIC RAYS IN INTERSTELLAR HYDROGEN
V. K. Balasubrahmanyan, E. Boldt, R. A. R. Palmeira (Southwest Center for Advanced Studies), and G. Sandri (Aeron. Res. Associates of Princeton, Inc.) Jul. 1967 21 p refs
(NASA-TM-X-55894; X-611-67-357) CFSTI: HC $3.00/MF $0.65 CSCL 20H

The temperature observed ($\approx 10^{2°}$K) for the hydrogen atoms of interstellar H1 clouds is shown to be a consistent measure of the Coulomb interactions of cosmic rays. These interactions could also give rise to a high electron concentration ($\approx 10^{-1}$ cm^{-3}). The expected intensity of Hα emission by the hydrogen atoms excited by cosmic rays is found to be comperable to but less than that measured from the galactic disk. The inner bremsstrahlung X-radiation by electrons ejected from interstellar hydrogen atoms is indicated as a direct measure of the spectrum of the cosmic rays responsible for the ionization. Author

N67-36447* National Aeronautics and Space Administration, Washington, D. C.
MODELS OF THE TRAPPED RADIATION ENVIRONMENT. VOLUME IV: LOW ENERGY PROTONS
Joseph H. King (Aerospace Corp., El Segundo, Calif.) 1967 66 p refs
(NASA-SP-3024) CFSTI: $3.00 CSCL 04A

To define a model radiation environment of the Earth, a model is presented of the low energy proton flux for energies below 4 MeV. Since the flux of low energy protons is intense, they may be the prime cause of deterioration of sensitive surfaces, and these effects are particularly important to temperature control surfaces, optical windows, or the first element in a counter telescope for studying nuclear radiation. The present trapped radiation environment describes protons trapped between L = 1.2 and L = 6.6. The energy range of validity is that over which a simple spectral representation suffices, but an attempt is made to ascertain whether a power law dependence or an exponential dependence is more representative of the data below 4 MeV. The distribution function J(>0.4 MeV; B, L) and spectral function E_0 (B, L) are presented in tabular form, and many graphical comperisons of the model with the data are provided. Orbital integration tables are presented for circular orbits up to 18,000 n. miles and for 15 energies and 14 energy bands. R.U.

N67-36517* Volt Technical Corp., Washington, D. C.
RELATIONSHIP BETWEEN THE RADIOEMISSION FLUX FROM LOCAL SOURCES AND THE STRUCTURE OF ACTIVE REGIONS OF THE SUN OBSERVED OPTICALLY [O SVYAZI POTOKA RADIOIZLUCHENIYA LOKAL NYKH ISTOCHIKOV NA SOLNTSE SO STROYENIYEM AKTIVNYKII OBLASTEY NABLYUDAYEMYKH OPTICHESKI]
A. R. Abbasov 25 Aug. 1967 4 p refs Transl. into ENGLISH from Dokl. Akad. Nauk SSSR, Ser. Astron., v. 174, no. 3, 1967 p 538–540
(Contract NAS5-12487)
(NASA-CR-88278; ST-SP-10638) CSCL 03B

This paper presents a statistical analysis of solar data for 1961 and 1963 in an attempt to broaden the possibilities of interpretation of the relationship between radioemission from local sources and the structure of the active regions of the Sun observable optically. Author

N67-36658*# State Univ. of Iowa, Iowa City. Dept. of Physics and Astronomy.
ELECTRON OMNIDIRECTIONAL INTENSITY CONTOURS IN THE EARTH'S OUTER RADIATION ZONE AT THE MAGNETIC EQUATOR
H. D. Owens and L. A. Frank Jul. 1967 31 p refs
(Grant NsG-233-62)
(NASA-CR-88359; Rept.-67-40) CFSTI: HC $3.00/MF $0.65 CSCL 04A

A comprehensive graphic display is presented of the omnidirectional intensities of electrons (E > 40 keV, > 230 keV, and > 1.6 MeV) in the outer radiation zone observed during the 10-month period October 1962 through July 1963 with an array of Geiger–Mueller tubes borne on the earth-satellite Explorer 14. The

observations are displayed as contours of constant omnidirectional intensities of electrons with energies exceeding the above thresholds as functions of shell-parameter L and time at the magnetic equator. Although many of the phenomena apparent in these maps of outer zone electron intensities have previously been discussed, the graphic summary provides an extensive panorama of the morphology of the energetic electron distributions in the outer zone and a compact, concise medium for comparison with related ground-based and satellite measurements of geophysical phenomena. Author

30 SPACE SCIENCES

Includes astronomy and astrophysics; cosmology; lunar and planetary flight and exploration; and theoretical analysis of orbit and trajectory. For related information see also: 11 Facilities, Research and Support; and 31 Space Vehicles.

N67-35341# RAND Corp., Santa Monica, Calif.
THE TWILIGHT CUSP EXTENSION OF VENUS
G. F. Schilling and R. C. Moore Jun. 1967 11 p refs Submitted for publication
(P-3621; AD-654628)

It has been known since about 1790 that when Venus is near inferior conjunction, the cusps of her crescent extend far beyond a half-circle. It is further known that Venus, at greatest elongation, does not present the expected half-moon shape, but rather appears convex towards the illuminated side. This leads to a discrepancy of the order of days between date of apparent and geometric dichotomy, not satisfactorily explained to date. On the basis of our study, we are forced to infer that the scattering atmosphere of Venus extends to considerable heights above the cloud deck, and that its luminosity characteristics are not too far different from those of the earths atmosphere. Height variations of the scattering atmosphere itself appear therefore to be immaterial, but small height variations of the probably uneven top of the opaque cloud deck would explain observed effects. TAB

N67-35369# Smithsonian Astrophysical Observatory, Cambridge, Mass.
MODEL ATMOSPHERES FOR COOL STARS. MODEL ATMOSPHERES FOR LATE-TYPE STARS
Owen J. Gingerich, D. W. Latham, J. L. Linsky, and S. S. Kumar 2 Jun. 1967 65 p refs
(SAO Special Rept.-240)

Serious problems beset the would-be constructor of stellar atmosphere models for cool stars: molecular absorptions, an involved equation of state, severe scattering, and convective instability. This paper describes early attempts to build models for $T_{eff} = 2500°$, including one with simulated water vapor absorption. Author

N67-35460*# Ohio State Univ., Columbus. Dept. of Electrical Engineering.
OSU LUNAR TWO-FREQUENCY EXPERIMENT
W. H. Peake, R. Turpin, and R. C. Taylor 27 Jul. 1967 18 p refs
(Grant NsG-213-61)
(NASA-CR-88019; Rept.-1388-24) CSCL 03A

Lunar surface properties were investigated experimentally using phase modulated radar transmissions. The lunar surface was illuminated with two waves at two different frequencies. The frequency difference is represented by $\Delta f = f_1 - f_2$. The scattered signals are correlated for various values of Δf, providing a correlation coefficient as a function of frequency separation. Data collected were subjected to analog-to-digital conversion processing and compared with theoretical predictions. Experimental results suggest that the rms height of the visible lunar surface is about 500 meters. General agreement of the experimental enhanced correlation function with the theoretically predicted behavior tends to verify the theoretical basis of this type of experiment. A Scatran program used in the computations is included. E.C.

N67-35541*# National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.
COMPARATIVE LUNAR-TERRESTRIAL COLORIMETRY
R. M. Hively and J. K. Westhusing (Lockheed Electron. Co.) [1966] 41 p refs
(NASA-TM-X-58008) CFSTI: HC $3.00/MF $0.65 CSCL 03A

The postulated use of lunar-surface colorimetry to establish surface composition and rock type is evaluated in this paper. The study examines the methods of measuring color, a brief history of lunar color observations, the limitations of lunar colorimetric studies, and the results of a laboratory colorimetric study of terrestrial materials. The resulting data are correlated with colorimetric data from selected lunar regions. From these comparisons it was concluded that: (1) spectrophotometric curves are necessary to make meaningful correlations between the colorimetric properties of lunar and terrestrial materials; (2) several terrestrial volcanic rocks exhibit colorimetric similarities to lunar surface areas; (3) the statistical approach offers the best correlation between rock type and color and, from this, a correlation with lunar surface color; and (4) pulverizing samples to smaller particle size causes increased brightness and increased sample redness. Author

N67-35547# Electronic Systems Div., Bedford, Mass.
AN ANALYTICAL FORMULATION FOR A SATELLITE GROUND-TRACE
H. R. Betz Jun. 1967 18 p
(ESD-TR-67-351; AD-655088)

The report derives the analytical expressions for an earth satellite ground track for a general elliptical, a circular and a circular-synchronous orbit under the assumptions of two-body conditions and in the absence of perturbations. Author (TAB)

N67-35668*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
AN EXPLICIT SOLUTION FOR THE LAGRANGE MULTIPLIERS ON THE SINGULAR SUBARC OF AN OPTIMAL TRAJECTORY
Rowland E. Burns Washington, NASA, Sep. 1967 36 p refs
(NASA-TN-D-4119) CFSTI: HC $3.00/MF $0.65 CSCL 22C

The problem of optimal thrust programming of a single stage rocket-powered vehicle to achieve maximum payoff at specified end conditions is discussed. The vehicle is assumed to operate in vacuo in an inverse square gravitational field. The Lagrange multipliers are analytically determined for the so-called singular arc and the mass flow rate to maintain a singular arc condition is derived. These Lagrange multipliers are directly related to the steering program by algebraic equations. Author

N67-35706*# Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.
BIOMAGNETICS: CONSIDERATIONS RELEVANT TO MANNED SPACE FLIGHT
Douglas E. Busby Washington, NASA, Sep. 1967 63 p refs
(Contract NASr-115)
(NASA-CR-889) CFSTI: HC $3.00/MF $0.65 CSCL 22A

This review defines the characteristics of possible magnetic field exposures in space and examines the biomagnetic literature in an attempt to determine whether or not such exposures could

affect astronaut performance and health. Directions for space-oriented research in this area are suggested. Exposures of various durations to magnetic fields of high and low intensities are considered, and radiation protection is discussed. Relevant aspects of magnetohydrodynamic propulsion systems are also briefly covered. K.W.

N67-35738*# Astro Research Corp., Santa Barbara, Calif.
METEOROID DAMAGE TO FILAMENTARY STRUCTURES
Richard H. MacNeal Washington, NASA, Sep. 1967 30 p refs
(Contract NAS7-427)
(NASA-CR-889; ARC-R-222) CFSTI: HC $3.00/MF $0.65 CSCL 03B

Fracture rates due to micrometeoroid impact are computed for solid round wires, flat tapes and thin-walled hollow tubes. The calculations are based on an extension of test data for the penetration of flat plates and on recent (1965) estimates of meteoroid flux. The results show that solid wires are much more vulnerable to meteoroid damage than either flat tapes or hollow tubes. Author

N67-35770*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
RESEARCH AND ADVANCED DEVELOPMENT. VOLUME II SUPPORTING RESEARCH AND TECHNOLOGY FOR THE OFFICE OF SPACE SCIENCES AND APPLICATIONS, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
Semiannual Review, 1 Jul.–31 Dec. 1966
Frank E. Goddard, Jr. 31 Jan. 1966 402 p refs
(Contract NAS7-100)
(NASA-CR-88088; JPL-TM-33-272, Vol. I) CFSTI: HC $3.00/MF $0.65 CSCL 22A

Supporting research and technology is described in summary form under the headings: lunar and planetary exploration; physics and astronomy; bioscience; and manned space sciences. Individual progress reports are included in relation to instrumentation, space chemistry, ionospheric and radio physics, astronomy, planetology, and planetary atmospheres. Physics and astronomy concepts are briefly described in their relationship for magnetometers in space, energetic particles, and sounding rockets. Spectral photography, and airborne microwave radiometry work are outlined in general terms under manned space science research. R.U.

N67-35798*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
MINIMUM FUEL ASCENT FROM THE LUNAR SURFACE
Albert E. Brown Washington, NASA, Sep. 1967 23 p refs
(NASA-TN-D-4159) CFSTI: HC $3.00/MF $0.65 CSCL 22A

The steepest-descent method is used to compute minimum fuel lunar launch trajectories consisting of two thrust phases separated by a coast phase terminating in an 80-nautical-mile circular orbit around the moon. Propulsion is provided by a constant-thrust and mass-flow-rate engine with a shutdown and restart capability. Three-dimensional point-mass equations of motion subjected to a spherical inverse-square gravitational field are used in simulating the lunar launch trajectories. Provision is made to optimize initial azimuth, first thrust duration, ballistic coast duration between the first and second thrusting phases, second thrust duration, and thrust orientation. The launch sites considered range from a launch site in the plane of the target orbit up to and including one displaced 30° (offset) from the target orbit. It was found that as the initial launch-site offset is increased, the trajectories steepen, the required angular travel to orbit injection is reduced, and for the larger offset values the altitude during coast exceeds the altitude of the target orbit. The amount of fuel required for orbit injection was found to increase almost linearly with initial launch-site offset. Author

N67-35966# Smithsonian Astrophysical Observatory, Cambridge, Mass.
ORBIT DETERMINATION
E. M. Gaposchkin *In its* Geodetic Parameters for a 1966 Smithsonian Inst. Std. Earth, Vol. 1 1966 p 77–183 refs Revised (See N67-35962 21-13)
(SAO Special Rept.-161, Rev.)

Orbit determination from improved numerical estimates of the satellite's motion in time and space is discussed. The mechanics of the satellite's motion in both the celestial (inertial) and the terrestrial system are expressed mathematically. Consideration is also given to the quasi-inertial reference system, satellite ephemeris, and parameter estimation by the least squares method. Long-period and secular oblateness perturbations, as well as short-period oblateness perturbation, are developed analytically, and equations are also derived for the moon's effect on the satellite orbit. R.U.

N67-35967# Smithsonian Astrophysical Observatory, Cambridge, Mass.
THE ORBITAL METHOD
George Veis *In its* Geodetic Parameters for a 1966 Smithsonian Inst. Std. Earth, Vol. 1 1966 p 185–190 refs (See N67-35962 21-13)

An analytical method is presented for determining the location of new satellite observation stations. Results obtained by the complete iterative method were used for positioning 12 Baker–Nunn photographic stations. Numerous, well distributed observations can provide unbiased results. A variation of the method of weighting observations is also described. R.U.

N67-35979 Massachusetts Inst. of Tech., Cambridge. Center for Space Research.
FIRST-ORDER ANALYSIS OF SUNBLAZER ORBITS
John V. Harrington Oct. 1966 17 p
(CSR-TR-66-10)

A numerical analysis is performed to determine the most desirable heliocentric orbit for the Sunblazer space probe. Retrograde injection, direct injection, and the effect of injection errors are considered. Characteristics of the most desirable orbit are listed. R.N.A.

N67-36001# Grumman Aircraft Engineering Corp., Bethpage, N. Y. Research Dept.
POLARIMETRY OF A LIMONITE SURFACE AS A FUNCTION OF WAVELENGTH AND PARTICLE SIZE
W. G. Egan Aug. 1967 10 p refs Presented at the 48th Ann. Meeting of the Am. Geophys. Union, Washington, D. C., 17–20 Apr. 1967
(RM-371J) CFSTI: HC $3.00/MF $0.65

The bearing and wind-scour properties of limonite, a possible major constituent of the Martian surface, are thought to be dependent on the porosity and the size and arrangement of the limonite particles. To delineate the effect of particle size on the polarimetric characteristics of limonite as a function of wavelength, a series of experiments was performed. The particle sizes studied were <1μ, <38μ, 38 to 88μ, 0.42 to 1.19 mm, 1.19 mm to 2.38 mm, and centimeter-sized chunks. Polarimetric observations were made in the blue (0.48μ), green (0.54μ), and infrared (1.0μ) wavelength regions. The observations on the large samples were made with a large-scale polarimeter (87 mm diameter viewing area and 3.8 meter arms). The best compatibility to the polarimetric observations of Mars by Dollfus are for the 1.19 to 2.38 mm particles. At zero-degree viewing angle and 40° phase angle in B(0.48μ) and G(0.54μ), the polarizations are +3.5% and +2.7%, compared to Dollfus' +3.0% and +2.7% at 0.50μ and 0.53μ; the corresponding 60° viewing angle results are +3.7%, and +3.0%. The 0° inversion angles are within 1-1/2° of those observed by Dollfus, the negative minima within 0.1%, and the locations of the negative minima within 1° Author

N67-36079*# General Motors Corp., Santa Barbara, Calif. Defense Research Labs.
ROVING VEHICLE MOTION CONTROL Quarterly Report, 1 Mar.–31 May 1967
B. P. Miller, T. M. Corry, D. E. Johnson, R. J. Johnston, and J. E. Lingerfelt. Jun. 1967 75 p refs Prepared for JPL
(Contracts NAS7-100; JPL-951829)
(NASA-CR-88285; TR67-34; QR-1) CFSTI: HC $3.00/MF $0.65 CSCL 22C

The problem of remote control of extraterrestrial roving vehicles is developed in terms of discrete increases in the level of difficulty associated with increasing orders of magnitude of the distance between the roving vehicle and the control center. The basic astrodynamic and astrophysical constraints operative in the lunar and planetary cases are defined, and the basic parameters of the Deep Space Network that pertain to remote control of roving vehicles are outlined. A rationale is described for the generic characterization of roving vehicle missions in terms of basic functions, operation modes, and navigation requirements. In addition, three distinctly different terrain models are postulated. The formalization of system requirements from these mission characteristics and terrain models is demonstrated by carrying an example through successive levels of detail to arrive at a level suitable for the assignment of hardware and software functions and the preliminary systems configuration. The state-of-the-art in the hardware subsystem technologies is reviewed in order to establish a basis for subsequent system mechanization and parametric tradeoff analysis. Author

N67-36098# Sterrewacht Sonnenborgh, Utrecht (Netherlands).
CONCLUSIONS CONCERNING THE GENERAL MAGNETIC FIELD OF THE SUN
M. G. J. Minnaert Florence, Comitato Nazl. per le Manifestazioni Celebrative, 1966 3 p Presented at the Conf. on Concerning the General Magnetic Field of the Sun
CFSTI: HC $3.00/MF $0.65

The position of the magnetic axis of the magnetic field in the corona was found to be erratic, judging from the polar brushes. The investigation of the polar brushes is considerably precise, but eclipses are rare and only a few photographs can be obtained. Up to now, the position of the axis has been determined with respect to Carrington's axis, but this axis now has to be carefully compared to the axis of rotation, which should be done by investigating exclusively the paths of the sunspots over the disc in the course of the 14 days of their passage. While the paths of the spots are yielding the axis of rotation, the spot positions yield the magnetic axis. Both can and should be determined separately. A method by which the magnetic field can be directly measured in photospheric layers is briefly commented upon. L.S.

N67-36172*# California Univ., Los Angeles. Dept. of Engineering.
USE OF VARIABLE LIFT CONTROL TO OPTIMIZE AERODYNAMIC BRAKING FOR A MARS ENTRY VEHICLE
R. A. Niemann Jul. 1967 30 p refs Prepared for JPL
(Contract NAS7-100; Grant NsG-237-62; Contract JPL-951889)
(NASA-CR-88363; Rept.-67-34) CFSTI: HC $3.00/MF $0.65 CSCL 22A

The use of variable lift control to obtain maximum velocity reduction through aerodynamic braking for Mars entry is considered. The method of lift control used is that of rolling the lift vector about the vehicle's stability axis so that the lift vector may either point upward or downward in the vertical plane. Through this method of lift control, it is shown that the maximum allowable ballistic coefficient which may be used to obtain a specific terminal velocity can be doubled over that which may be used with a constant L/D lifting vehicle. Also, it is shown that the minimum velocity attainable for a given ballistic coefficient and atmosphere is the same for all entry conditions. Author

N67-36393*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
INTERPLANETARY MAGNETIC FIELD MAPPING AND STUDY OF SECTOR EVOLUTION
Norman F. Ness, Kenneth H. Schatten, and John M. Wilcox (Calif. Univ., Berkeley) Aug. 1967 38 p refs
(Grant NsG-659; Contract Nonr-365(26))
(NASA-TM-X-55889; X-612-67-424) CSCL 03B

The interplanetary magnetic field has been mapped between 0.4 and 1.2 AU in the ecliptic plane by extrapolating satellite measurements at 1 AU. In this manner structure within sectors is discussed and the evolution of sectors is observed. The evolution of a bipolar magnetic region on the sun is seen to produce a convected magnetic loop in the interplanetary medium giving rise to the birth of a new sector. Author

N67-36394*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
A BALLOON BORNE X-RAY SURVEY OF THE CENTRAL REGION OF THE GALAXY
Elihu Boldt, Henry Doong, Peter Serlemitsos, and Guenter Riegler (Md. Univ.) Aug. 1967 13 p refs Presented at the 10th Intern. Conf. on Cosmic Rays, Calgary (Canada), June 1967
(NASA-TM-X-55887; X-611-67-369) CFSTI: HC $3.00/MF $0.65 CSCL 03B

A balloon borne X-ray survey of the galactic plane in the region of the galactic center was made from Australia during December 1966. The photon events recorded by a detector composed of a krypton gas proportional counter and a cesium iodide scintillation crystal are used to determine the spectrum of hard X-rays from the vicinity of Sgr XR-1. Author

N67-36460*# California Univ., Los Angeles. Space Science Center.
SPACE PROGRAM
W. F. Libby Dec. 1966 75 p
(Grants NsG-216-62; NsG-249-62; NsG-313-63; Contracts NAS5-9570; NAS5-9097)
(NASA-CR-88283) CFSTI: HC $3.00/MF $0.65 CSCL 22A

Summaries of progress on space related research activities are presented. Physical science activities discussed include: 1) earth satellite experiments, 2) planetary and lunar constitution, 3) meteorite composition, 4) solar phenomena, 5) geophysical data, 6) particles and fields in space, 7) plasmas, 8) telescopes, and 9) use of a large laser beam. Biological science activities discussed include: 1) monitoring of brain functions in primates under weightlessness, 2) tissue studies, 3) pattern recognition of sensory signals in animals, and 4) bioinstrumented physiological studies with animals. Engineering research activities discussed include: 1) surface temperature measurements, 2) jet diffusion flames as chemical kinetics tool, 3) plasma studies on solids, 4) microwave studies on semiconductors, 5) structural materials, 6) crystal lattices, 7) gas dynamics, and 8) photodetectors. Other work efforts in the above, and in social sciences and business administration, are also presented. L.S.

N67-36504# Chile Univ., Santiago. Dept. of Astronomy.
A SYSTEM OF PHOTOMETRIC STANDARDS
A. Gutierrez-Moreno, H. Moreno, J. Stock, C. Torres, and H. Wroblewski [1965] 18 p refs
(Publ.-1)

A refined method of determining and eliminating the effects of atmospheric extinction on photometric data is derived on the basis of the color-dependence of the extinction coefficients observed in wide-band photometry. For colors involving the ultraviolet an additional correction of the extinction depending on the Balmer depression is included. A total of 366 stars has been observed photoelectrically at the Cerro Tololo Inter-American Observatory in the UBV-system introduced by Johnson and Morgan. Magnitudes and colors in a new UBV-system are communicated for these

stars. The magnitudes and the (B–V)-colors are compatible with the Johnson–Morgan system, while the (R–B)-colors are incompatible for stars of certain types due to extinction residuals contained in previous (U–B)-data. A number of new suspected variable stars are also communicated in the catalogue. Author

N67-36586# Toronto Univ. (Ontario). Inst. for Aerospace Studies.
AN ATTITUDE CONTROL SYSTEM TO CONSTRAIN THE SKIN TEMPERATURE OF A MANNED LIFTING SPACECRAFT DURING REENTRY INTO THE EARTH'S ATMOSPHERE
Jerome H. Fine Jul. 1967 151 p refs
(Grants AF-AFOSR-222-63; AF-AFOSR-222-64; AF-AFOSR-222-66)
(UTIAS-126; AFOSR-67-0858; AD-654732)

An attitude control system to regulate the temperature of a manned lifting spacecraft during reentry into the Earth's atmosphere is proposed. Its use prevents the peak skin temperature that is experienced during the reentry from rising moderately beyond that which would occur during an equilibrium glide of the same vehicle. The effects of Earth rotation and oblateness upon the performance of the attitude control system were found to be moderate and predictable. The maximum temperature increment associated with them was found to be only 100F for the worst set of initial conditions. The cross range shift of the footprint due to rotation was found to be within 70 miles of the value that would occur for the corresponding orbit in vacuum. Oblateness could generally be accounted for by using the effective initial glide angle relative to the Earth's surface rather than the geocentric initial value relative to the central coordinate system. The results of density variation in the Earth's atmosphere were not serious. Large increases in the maximum skin temperature occurred only when extremely large spatially random density disturbances were encountered by the vehicle. Author (TAB)

N67-36602*# Stanford Univ., Calif. Dept. of Aeronautics and Astronautics.
MINIMUM-FUEL ATTITUDE CONTROL OF A RIGID BODY IN ORBIT BY AN EXTENDED METHOD OF STEEPEST-DESCENT
K. A. Hales and I. Fluegge-Lotz Jan. 1966 145 p refs
(Grant NsG-133-61)
(NASA-CR-79112; SUDAAR-257) CFSTI: HC $3.00/MF $0.65 CSCL 22A

An extended method of steepest descent was used to solve the minimum fuel optimization problem for two nonlinear, sixth-order mathematical models; and to generate approximately optimal trajectories for the spacecraft attitude acquisition problem. The state trajectories generated by this method are compared with those generated by an idealized 3 axis proportional state feedback control system. It was found that trajectories generated by the former technique consumed less fuel, acquired the desired orientation more quickly, and used lower control torque magnitudes than those required by the feedback scheme. A comparison is found between trajectories generated by steepest-descent and true optimal trajectories. The extended method of steepest-descent was found to provide similar trajectories which satisfy the terminal constraints while using as much as 15% more fuel than optimal. It is concluded that a primary contribution of this method is that it can be used to generate a set of nearly optimal state trajectories, starting from a finite set of arbitrary initial conditions, which may be used as design goals for sub-optimal acquisition control schemes. S.C.W.

N67-36610* Volt Technical Corp., Washington, D. C.
INITIAL RADIUS OF AN IONIZED METEOR WAKE [NACHAL'NYY RADIUS IONIZIROVANNOGO METEORNOGO SLEDA]
V. N. Lebedinets and Yu. I. Portnyagin 19 Sep. 1966 8 p refs Transl. into ENGLISH from Geomagnetizm i Aeronomiya (Moscow), v. 6, no. 4, 1966 p 713–718
(Contract NAS5-12487)
(NASA-CR-81706; ST-IM-10515) CSCL 03B

Taking into account the dependence of the effective diffusion cross section of meteoric atoms in the atmosphere on meteor velocity, the initial radius of an ionized meteor wake is computed. Inasmuch as the initial widening of the wake takes place mainly at the expense of the first few path lengths of vaporized particles, the initial contribution to the initial radius of individual paths is considered. The obtained values of the initial radius R_i satisfy the condition $0.93\ l_0 < R_H < 1.5\ l_0$ where l_0 is the length of the free path of vaporized particles for a given velocity of meteors. The computed values of the initial radius are in good agreement with the results of radar measurements of the initial radius conducted in Khar'kov, Kiyev and Jodrell Bank. Author

N67-36636*# RAND Corp., Santa Monica, Calif.
ORBITAL REGRESSION OF SYNCHROMOUS SATELLITES DUE TO THE COMBINED GRAVITATIONAL EFFECTS OF THE SUN, THE MOON AND THE OBLATE EARTH
R. H. Frick Aug. 1967 185 p refs
(Contract NASr-21)
(NASA-CR-88355; NASr-21(02); R-454-NASA) CFSTI: HC $3.00/MF $0.65 CSCL 22C

An analysis of the long-term behavior of earth satellites due to the gravitational effects of the sun, the moon and the oblate earth is presented. The analysis applies to satellites in near-circular orbits at any inclination and with orbital radii which are small compared to the radius of the moon's orbit (i.e., less than 10 earth radii). The formulation takes into account the rotation of the earth around the sun, the rotation of the earth–moon system about its center of mass, and the regression of the moon's orbital plane about the normal to the ecliptic. Author

N67-36637# Observatorio de Cordoba (Argentina).
ON THE EXPLOSIVE ORIGIN OF THE GALAXIES [SOBRE EL ORIGEN EXPLOSIVO DE LAS GALAXIAS]
J. L. Sérsic Oct. 1966 20 p ref In SPANISH Sponsored by the Natl. Res. Council, Buenos Aires
CFSTI: HC $3.00/MF $0.65

Details are presented of a proposed theory on the origin of galaxies. The theory states that irregular and spiral galaxies are the result of violent ejections of material produced in eliptic galaxies of large mass. R.N.A.

N67-36661* Volt Technical Corp., Washington, D. C.
MEASUREMENTS OF GAMMA RADIATION OF THE LUNAR SURFACE ON THE SPACE STATION LUNA-10
A. P. Vinogradov, Yu. A. Surkov, G. M. Chernov, F. F. Kirnozova, and G. B. Nazarkina 31 Aug. 1967 25 p refs
(Contract NAS5-12487)
(NASA-CR-88277; ST-LPS-ACH-10643) CSCL 03B

Data are presented which complete the preliminary results of lunar gamma radiation measurements conducted with the aid of the scintillation gamma spectrometer installed on LUNA-10. Also included are new data on the spectral composition and the results of gamma radiation intensity measurements above different regions of the lunar surface. This is preceded by a thorough review of all possible sources of lunar gamma radiation. The types of lunar rocks are determined by the gamma radiation due to the natural radioactive elements contained in them. On the basis of these results it is confirmed that the rocks of lunar continental regions are probably represented by ultrabasic (chondritic) formations or by a mixture of basic and ultrabasic rocks, while the maria are composed of rocks similar to terrestrial basalts. Author

N67-36666# Lockheed Missiles and Space Co., Huntsville, Ala. Research and Engineering Center.
THE LIBRATIONAL MOTION OF A SATELLITE WITH LARGE PANELS
Chang-po Liu [1967] 24 p refs

The effect of aerodynamic forces and torques on a satellite which slowly oscillates around its center of mass under gravitational attraction is studied. The asymptotic method of Krylov and Bogliubov is used for the calculation of average aerodynamic and gravity gradient torques. A satellite with large panels which initially is inclined slightly to the stream is found to undergo stable librational motion if the orbit is sufficiently high and certain other conditions are satisfied. Results also show that for a librating satellite the aerodynamic damping torques are so small that they cannot be efficiently used for the control of the satellite's attitude.
Author

31 SPACE VEHICLES

Includes launch vehicles; manned space capsules; clustered and multistage rockets; satellites; sounding rockets and probes; and operating problems. For basic research see: 30 Space Sciences. For related information see also: 28 Propulsion Systems; and 32 Structural Mechanics.

N67-35375*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
CENTAUR AC-6 NOSE FAIRING SEPARATION TESTS
Jack H. Humphrey and Charles W. Eastwood, Jr. Washington, NASA 1967 120 p
(NASA-TM-X-52290) CFSTI: HC $3.00/MF $0.65 CSCL 22B

The flight qualification tests of the AC-6 Centaur nose fairing by simulated separation of the fairing from the Centaur vehicle are described. It was necessary to qualify several new parts of the nose fairing not qualified in previous tests and to determine loads imposed by the fairing on the Centaur forward bulkhead during separation. The tests were conducted under pressure conditions encountered by Centaur at the time of nose fairing flight separation (approximately the pressure at 350,000 foot altitude) but without simulation of the actual flight acceleration (approximately 1.25g). Data presented give pressures, forces, displacements, and accelerations encountered by the nose fairing separation in each test. It was determined by these tests that all parts of the nose fairing in the final test configuration were suitable for their proposed use. In addition, it was determined that the loads transmitted through the nose fairing hinges to the Centaur tank during separation were within the allowable loads for the tank. Because of these tests, it was necessary to change the envelope within the nose fairing due to static interference and possible dynamic interference between thermal bulkhead struts and the Surveyor envelope.
Author

N67-35383* Boeing Co., Seattle, Wash. Space Div.
LUNAR ORBITER ADAPTABILITY TO OTHER SCIENTIFIC INVESTIGATIONS
Gregory Baran 7 Aug. 1965 265 p refs
(Contract NAS1-4959)
(NASA-CR-66448; D2-100369-1) CSCL 22B

Presented are results of a study to determine the degree to which the Lunar Orbiter (in its present or in a modified form) is capable of supporting other scientific experiments. The study shows that other experiments can be accommodated by minor hardware changes because of the operational flexibility available in the present design.
Author

N67-35448*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
RANGER LAUNCH VEHICLE INTEGRATION SUMMARY
W. J. Lane and D. J. Stelma 27 Jun. 1967 272 p refs
(Contract NAS7-100)
(NASA-CR-88008; ED-333, Rev.) CFSTI: HC $3.00/MF $0.65 CSCL 22D

A chronology is presented on the development of the Ranger Project launch vehicle system and its adaptation for use in achieving mission objectives. The Block designation is used in discussing the continuous test programs and constant evaluations, and to separate the missions. Block I (Rangers I and II) were engineering evaluation flights for testing the basic systems and were not specifically lunar-oriented. Block II (Rangers III, IV, and V) carried a gamma-ray instrument, a TV camera, and a rough-landing seismometer capsule. Block III (Rangers VI, VII, VIII, and IX) objectives were to obtain pictures of the lunar surface at least one order of magnitude better than those obtainable with earth-based photography. Requirements for integrating the spacecraft with the Atlas D/Agena B launch vehicle are defined, and details are provided on the necessary documentation. Static and dynamic compatibility test data are presented, along with the results of such special tests as hot firing, smoke, temperature control, and end-to-end calibration. A reference bibliography is included.
M.G.J.

N67-35546*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
SPACE PROGRAMS SUMMARY NO. 37-30, VOLUME VI FOR THE PERIOD SEPTEMBER 1, 1964 TO OCTOBER 31, 1964. SPACE EXPLORATION PROGRAMS AND SPACE SCIENCES
30 Nov. 1964 36 p
(Contract NAS7-100)
(NASA-CR-88087; JPL-SPS-37-30, Vol. VI) CFSTI: HC $3.00/MF $0.65 CSCL 22B

An orbital trajectory analysis of the Ranger 7 spacecraft is presented; and the launch-to-injection environment for the vehicle is investigated. Systems development for the Surveyor spacecraft is reported for scientific payload, flight control, electronics, thermal control, propulsion, electrical power supply, and other systems. Flight and thermal tests for various Mariner spacecraft are described. Tracking stations engineering and operations, an advanced antenna system for the Deep Space Instrumentation Facility, and special power supplies for the Space Flight Operations Facility are described.
L.S.

N67-35557*# General Dynamics/Convair, San Diego, Calif.
ANALYSIS AND DESIGN OF SPACE VEHICLE FLIGHT CONTROL SYSTEMS. VOLUME XII: ATTITUDE CONTROL IN SPACE
Arthur L. Greensite Washington, NASA, Aug. 1967 166 p refs
(Contract NAS8-11494)
(NASA-CR-831; GD/C-DDE67-001) CFSTI: HC $3.00/MF $0.65 CSCL 22B

The attitude control problem for a satellite in earth orbit is considered with emphasis on the analysis and synthesis of attitude control systems. The present status of attitude control systems, the systems used by various satellites, and some of the problems that have been encountered are discussed. In outlining recommended design procedures, attention is given to the choice of coordinate reference frames, the development of motion equations, the selection of actuators, and the evaluation of disturbance torques. An attempt is made to present a unified point of view and a general framework within which a variety of specialized missions may be analyzed. The discussion emphasizes analytical tools and conceptual control philosophies; however, necessary design data are included where appropriate, along with the summarized results of various numerical studies.
R.N.A.

N67-35595*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
PROCESSING THE DATA FROM THE OGO-III GEGENSCHEIN PHOTOMETRY EXPERIMENT
John H. Quann Aug. 1967 159 p
(NASA-TM-X-55907; X-565-67-403) CSCL 22B

The objectives, apparatus, data generation and display, and data analysis system of the Gegenschein Photometry Experiment performed aboard the OGO-B spacecraft, are discussed. The experiment is intended to provide information for gaining a better understanding of the earth and earth–sun relationships. The procedure for using the system is described. Program control, user options, run execution, control card formats, subroutines, and computation procedures are discussed. Output examples are given. L.S.

N67-35640# Rome Air Development Center, Griffiss AFB, N. Y. Communications Research Branch.
LOW TEMPERATURE SATELLITE THERMAL STUDY Final Report, Oct. 1963–Oct. 1964
Peter N. Edraos and Mark W. Levi Jun. 1967 76 p refs
(RADC-TR-67-128; AD-654325)

It is known that superior performance can be obtained from various electronic devices operating at very low temperatures. We consider the problem of constructing a communications satellite that contains some volume that can be maintained at low temperature, at least below 77 Kelvin, and the cooling process to be that of radiative emission alone. A worst-case thermal equilibrium analysis is done for a synchronous 24-hour orbit. Assuming heat transfer within a differential satellite volume to be due to both radiation and conduction, a 2nd-degree nonlinear differential equation with a quartic term is obtained, whose solution is described by Emden to be non-analytic. A computer solution to the temperature distribution function is obtained by successive expansion in 6th-order polynomials. The results indicate that the desired low temperatures can be reached and maintained with presently available materials, and if there is a satellite attitude error of less than 5 degrees. Author (TAB)

N67-35689*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
DATA PROCESSING PLAN FOR ECCENTRIC ORBITING GEOPHYSICAL OBSERVATORY (OGO-B)
John J. Quann Mar. 1966 155 p
(NASA-TM-X-55890; X-564-66-101) CSCL 22B

To expand information of the earth and of earth–sun relationships, the OGO-B (orbiting geophysical observatory) mission is planned to carry a large number of varied geophysical experiments into a highly eccentric orbit around the earth. The projected orbit allows the OGO-B to traverse the radiation belts twice during each orbit and to make geophysical measurements from the region near the earth to cislunar space. The data processing plan presented provides details on ground station operations, processing systems, and processing operations. The 20 experiments are outlined, and the spacecraft telemetry and data-handling system is described briefly. R.U.

N67-35740*# Boeing Co., Seattle, Wash.
LUNAR ORBITER I. EXTENDED-MISSION SPACECRAFT SUBSYSTEM PERFORMANCE
Washington, NASA, Sep. 1967 62 p
(Contract NAS1-3800)
(NASA-CR-870; D2-100727-5) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Following the primary Lunar Orbiter I mission, additional scientific data was obtained during that phase of flight designated as the extended mission. The performance and operation of each spacecraft subsystem during this extended mission are described in detail, and include the attitude control subsystem, communications subsystem, power subsystem, photo subsystem, structure and mechanisms, and velocity and reaction control subsystems. Also included are descriptions and results of special exercises performed to test the spacecraft and equipment aboard. R.N.A.

N67-35778*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
FAR-FIELD ACOUSTIC ENVIRONMENTAL PREDICTIONS FOR LAUNCH OF SATURN V AND A SATURN V MLV CONFIGURATION
Stanley Guest and Jess H. Jones Washington, NASA, Sep. 1967 35 p refs
(NASA-TN-D-4117) CFSTI: $3.00 CSCL 22D

A technique which considers sound source characteristics and the effects of vehicle trajectory was used to provide the sound pressure levels given in this report. The nominal engine operational parameters and trajectory parameters were used for the computations. Several typical maximum overall sound pressure level time histories for various ground observation points were obtained from the sequence of predicted spectra at various times of occurrence for a given ground position. These time histories provide a protective criteria to insure safety of personnel and structures. Acoustic environments were similarly predicted for a configuration of the Modified Launch Vehicle (MLV) for adaptation of the Saturn V. This configuration is a solid propellant strap-on increasing the total booster stage thrust to 142.3×10^6 N (32×10^6 lbf). The acoustic spectral environments are given in octave band sound pressure level (dB, ref: 2×10^{-5} N/m^2) versus frequency with the respective overall or composite levels; they represent the mean of the fluctuating levels which are expected. An isentropic homogeneous atmosphere producing no focusing conditions was adopted for predicting the environments. K.W.

N67-35885*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
LUNAR FAR-SIDE COMMUNICATION SATELLITES
P. E. Schmid 28 Jul. 1967 31 p refs
(NASA-TM-X-55886; X-507-67-328) CFSTI: HC $3.00/MF $0.65 CSCL 22B

An estimate of the data relay and tracking capability of a lunar communication satellite relaying signals to and from points on or up to 200 km above the lunar far-side surface is presented. Two lunar satellite geometries are considered; namely, a libration point satellite anchored 65,000 km behind the moon and a 1000 km altitude satellite in circular polar lunar orbit. Author

N67-35913# Societe pour l'Etude et la Realisation d'Engins Balistiques, Courbevoie (France).
SPINE-UP SYSTEM. BOOST PHASE DISPERSIONS [MISE EN ROTATION. DISPERSION EN PHASE PROPULSEE]
Dec. 1964 68 p In FRENCH Prepared for ELDO
(DTA-50-4644, Append. I) CFSTI: HC $3.00/MF $0.65

Errors in attitude and velocity involved in placing a spin-stabilized apogee stage satellite into an 8 hr polar orbit are discussed. These errors occur during (a) extinction of the third stage motor of ELDO A-S launch vehicle, (b) separation of the third stage, and (c) transfer orbit and apogee boost phase. ESRO

N67-35914# Societe pour l'Etude et la Realisation d'Engins Balistique, Courbevoie (France).
PRELIMINARY STUDY OF APOGEE STAGE OF EUROPA I LAUNCH VEHICLE [AVANT-PROJET D'ESTAGE D'APOGEE DU LANCEUR EUROPA I]
Dec. 1964 98 p In FRENCH Prepared for ELDO
(DTA-50-4644) CFSTI: HC $3.00/MF $0.65

A possible apogee stage is described which includes a satellite, for the ELDO launch vehicle EUROPA I, which gives the capability of injecting the satellite into an 8 hr polar orbit and is

suitable for telecommunications. Means of separation, injection into orbit, guidance, payload, development, and costs are considered. Equipment details and specific problems concerning spin-stabilization, inertial guidance laws, satellite thermal control, and orbital guidance are presented in five separate annexes. ESRO

N67-35932# European Space Research Lab., Noordwijk (Netherlands).
DESCRIPTION OF SCIENTIFIC SOUNDING-ROCKET PROJECT S-18
R. Jaeschke Paris, ESRO, Feb. 1967 15 p refs
(ESRO-SN-67) CFSTI: HC$3.00/MF$0.65

In order to elucidate the role played by photochemical processes in cometary tails, a cloud of NH_3 is ejected at an altitude of about 200 km, under twilight conditions. The fluorescence spectra of NH_2 and NH under the action of solar radiation are observed from the ground by means of a variety of spectrographs. The study of the variations of the spectral intensities for the two radicals will lead, it is hoped, to a better understanding of the dissociation and ionisation mechanism in such a cloud. In addition to the cometary aspects, the filming of the explosive and diffusive phases of the NH_3 cloud yields information on the physical properties of the upper atmosphere. In addition to its scientific payload, the rocket included some technological sensors (acceleration, pressure, temperature) whose data were telemetered to the ground throughout the flight. Author (ESRO)

N67-36013*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
RESEARCH AND ADVANCED DEVELOPMENT. VOLUME II: SUPPORTING RESEARCH AND TECHNOLOGY FOR THE OFFICE OF ADVANCED RESEARCH AND TECHNOLOGY, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION Semiannual Review, 1 Jul.–31 Dec. 1965
Frank E. Goddard, Jr. 31 Jan. 1966 490 p refs
(Contract NAS7-100)
(NASA-CR-66078; JPL-TM-33-272, Vol. II) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Objectives and development progress are summarized on the research projects being conducted for NASA's Office of Advanced Research and Technology. These pertain to nuclear electric systems; space power, including solar power and chemical power generation; space vehicle systems, covering spacecraft aerothermodynamics and structures, and space vehicle environmental factors and design criteria; electronic guidance and control systems; communications; man–system integration; liquid and solid propulsion technology; chemical rocket experimental engineering; fluid physics; electrophysics; materials; and applied mathematics. M.G.J.

N67-36032*# General Electric Co., Philadelphia, Pa. Missile and Space Div.
APPLICATIONS TECHNOLOGY SATELLITE GRAVITY GRADIENT STABLIZATION SYSTEM Quarterly Progress Report, 1 Feb.–30 Apr. 1967
20 May 1967 139 p
(Contract NAS5-9042)
(NASA-CR-88130; Doc.-67SD4292; QPR-11) CFSTI: HC $3.00/MF $0.65 CSCL 22B

During this period, the ATS-A was launched but due to an improper Agena D second burn, the spacecraft remained in a highly eccentric transfer orbit. The gravity gradient boom system was successfully deployed and all other gravity gradient stabilization system components performed nominally. A system flight performance analysis is presented along with a detailed performance analysis of each of the gravity gradient system components. The satellite's highly eccentric orbit produced noticeable flexible boom motions. An investigation of these boom dynamics is included. Also described are activities that were performed in connection with the development, testing, quality control, and manufacture of components of the gravity gradient stabilization system. R.N.A.

N67-36061# General Dynamics/Convair, San Diego, Calif.
ATLAS SPACE LAUNCH VEHICLE SYSTEMS SUMMARY
Feb. 1967 77 p
(GD/C-BGJ67-001)

System summaries are given for the airframe; pneumatic; hydraulic; propulsion; propellant utilization; electrical; flight control; guidance; telemetry; and range safety command subsystems. General requirements for the prelaunch checkout and countdown procedures for the ground support functions prior to launch of the Atlas Space Launch Vehicle are listed. L.S.

N67-36076*# Lockheed Missiles and Space Co., Sunnyvale, Calif.
THERMAL PROTECTION SYSTEM FOR A CRYOGENIC SPACECRAFT PROPULSION MODULE, VOLUME I Final Report
W. H. Sterbentz and J. W. Baxter 15 Nov. 1966 20 p
(Contract NAS3-4199)
(NASA-CR-54879, Vol. I; LMSC-A794993, Vol. I) CSCL 22B

The primary objective of the research was the development of a lightweight insulation that would limit liquid hydrogen boiloff to less than 5% of the initial propellant load during an eight day lunar mission. This objective, as well as other program objectives, was achieved. An optimum thermal protection system based on reflective multilayered insulation materials for the liquid hydrogen propellant tank of the cryogenic propulsion module was designed. The insulation system selected consists of a helium purged Fiberglass batting substrate for ground-hold insulation, overlaid with 36 layers of double aluminized 0.25 mil Mylar, separated by 2.8 mil Dexiglas paper. It is assembled in buttoned, modular panels. The support structure required to suspend the liquid hydrogen tank within the load-carrying outer shell of the vehicle was also designed. Photographs and drawings of the thermal protection system are included. H.S.W.

N67-36077*# Lockheed Missiles and Space Co., Sunnyvale, Calif.
THERMAL PROTECTION SYSTEM FOR A CRYOGENIC SPACECRAFT PROPULSION MODULE, VOLUME II Final Report
W. H. Sterbentz and J. W. Baxter 15 Nov. 1966 520 p refs
(Contract NAS3-4199)
(NASA-CR-54879, Vol. II; LMSC-A794993, Vol. II) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Details of the technical effort are presented. Graphs, curves and data tables, drawings, analyses, and evaluations are discussed. Information is given on the insulation systems design, tank structural support design, component and subscale model tests, half scale test module fabrication, half scale model tests, and full scale system design and fabrication specifications. A post test analysis of the test data was made. The conclusions drawn from this analysis and the recommended design changes are listed. H.S.W.

N67-36100*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
SPACE PROGRAMS SUMMARY NO. 37–29, VOLUME VI: FOR THE PERIOD JULY 1, 1966 TO AUGUST 31, 1966. SPACE EXPLORATION PROGRAMS AND SPACE SCIENCES
30 Sep. 1966 67 p refs
(Contract NAS7-100)
(NASA-CR-88105; JPL-SPS-37-29, Vol. VI) CFSTI: HC $3.00/MF $0.65 CSCL 22B

The summaries cover aspects of the Ranger, Surveyor, and Mariner Projects in addition to work on the Deep Space Network. Ranger VII operations, flight performance, guidance and control, the TV subsystem, and the power subsystem are discussed. Mission and spacecraft system developments of the Surveyor project are

reviewed. The article on the Mariner project covers mission and objectives, systems testing of the Mariner C-1, C-2, and C-3, data and spacecraft simulations, the flight command subsystem, the telemetry system, the Canopus tracker, and Mariner C TV subsystem camera shutter electronics. The discussion of Deep Space Network developments includes tracking stations engineering and operations, communications, and the antenna system at the Deep Space Instrumentation Facility. Display systems and the Surveyor on-site telemetry and command data handling system at the Space Flight Operations Facility are also discussed. K.W.

N67-36138# Sandia Corp., Albuquerque, N. Mex.
AEROBALLISTIC DEVELOPMENT OF THE SINGLE STAGE TOMAHAWK SOUNDING ROCKET SYSTEM
R. E. Gardner May 1967 44 p refs
(Contract AT(29-1)-789)
(SC-RR-2608) CFSTI: HC $3.00/MF $0.65

The Single Stage Tomahawk is a solid-propellant sounding rocket system capable of carrying a 125-pound payload to an apogee altitude of about 250,000 feet when launched from sea level. Aerodynamic design data, performance and dispersion estimates, and a summary of flight tests of the system are presented. Author (NSA)

N67-36150# Dornier-Werke G.m.b.H., Munich (West Germany).
GERMAN RESEARCH SATELLITE 625 A: INSTRUMENT TESTS WITH ALTITUDE RESEARCH ROCKET NIKE-APACHE BRD-I [DEUTSCHE FORSCHUNGSSATELLIT 625 A: INSTRUMENTENERPROBUNG MIT HOEHENFORSCHUNGS-RAKETE NIKE-APACHE BRD-AI]
[1966] 23 p In GERMAN Presented at the DGRR-Symp. Satelliten-Technik II, Munich, 8 Dec. 1966 *Its* Preprint No. 66-126

Design, development, construction, and test firing are described of a group of scientific experiments planned for inclusion in the German research satellite 625-A. The group of experiments consists of 2 photometers, 2 electron counters, 1 proton counter, and 2 magnetometers. The instruments were launched with a Nike-Apache to a height of 220 km into an aurora borealis over Canada. Some telemetry data from this successful firing are also presented. Transl. by K.W.

N67-36203*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
SECOND AEROSPACE MECHANISMS SYMPOSIUM
George G. Herzl, ed. 15 Aug. 1967 197 p refs Proc. held Aerospace Mech. Symp., Santa Clara, Calif., 4–5 May 1967
(Contract NAS7-100)
(NASA-CR-87990; JPL-TM-33-355) CFSTI: HC $3.00/MF $0.65
CSCL 22B

The problems encountered in designing mechanisms and mechanical components for aerospace applications and space environment performance are discussed. For individual titles, see N67-36204 through N67-36225.

N67-36205*# Lockheed Missiles and Space Co., Sunnyvale, Calif.
LATCH DIAPHRAGM RELEASE MECHANISM
G. Gibbons, A. Ventura, and A. Kaehler *In* JPL 2d Aerospace Mech. Symp. 15 Aug. 1967 p 9–14 (See N67-36203 21-31)

The design and development of a mechanism for the separation of payloads in space are described. Development test failures of the diaphragm and associated structures, and other development problems, are also discussed. The diaphragm release mechanism was qualified by (1) flight confidence tests demonstrating clean separation with no indication of release abnormalities, and (2) flight tests that proved the reliability of the integrated structure and the release mechanism. These tests satisfied the critical requirements for trajectory accuracy and release time. Author

N67-36208*# Boeing Co., Seattle, Wash.
LUNAR ORBITER PHOTO-SUBSYSTEM MECHANISMS
George Bradley *In* JPL 2d Aerospace Mech. Symp. 15 Aug. 1967 p 33–40 (See N67-36203 21-31)
(Contract NAS1-3800)

The design and development of the photo-subsystem that was successfully operated on the Lunar Orbiter spacecraft are described. The various components of the photo-subsystem, such as the film transport, vacuum and mechanical clamps, 24-in. focal-plane shutter, processor–dryer, and optical mechanical scan system, are described in detail. Author

N67-36209*# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.
YO–YO DESPIN MECHANISMS
Kenneth S. Bush *In* JPL 2d Aerospace Mech. Symp. 15 Aug. 1967 p 41–50 refs (See N67-36203 21-31)

The analytical background and practical design considerations are described for three principal types of yo-yo despin mechanisms: (1) single-stage (rigid), (2) two-stage, and (3) stretch yo-yo. The principal advantages of each method are enumerated and explained. The results of the calculations and of the actual flight tests for each type of yo-yo despin mechanism are also presented. Author

N67-36212*# Grumman Aircraft Engineering Corp., Bethpage, N. Y.
LUNAR MODULE ALIGHTMENT SYSTEM
Richard A. Hilderman, William H. Mueller, and Morton Mantus *In* JPL 2d Aerospace Mech. Symp. 15 Aug. 1967 p 67–78 ref (See N67-36203 21-31)

Important design features of the alightment system are described, such as geometric arrangement, energy absorber characteristics, and deployment mechanisms. Performance characteristics of the vehicle at touchdown, as found analytically, are presented. Model and full-size testing of the landing system is briefly discussed. Author

N67-36214*# General Electric Co., Philadelphia, Pa.
COLLET RELEASE MECHANISM
Daniel O. Ramos *In* JPL 2d Aerospace Mech. Symp. 15 Aug. 1967 p 85–92 (See N67-36203 21-31)
(Contracts AF 04(694)-389; AF 04(894)-473)

A novel, simple, reliable, and flight-proven mechanism, used to separate and eject a reentry vehicle payload from a booster is described. Design details, comparison with other solutions, test experience, and several flight-proven applications are included. Author

N67-36215*# Hughes Aircraft Co., Los Angeles, Calif.
THE SURVEYOR THERMAL SWITCH
T. E. Deal *In* JPL 2d Aerospace Mech. Symp. 15 Aug. 1967 p 93–100 (See N67-36203 21-31)

The external temperature extremes of the lunar surface dictated that a means be found to control the two electronic compartments on the Surveyor soft lunar landing vehicle within a narrower temperature band to assure satisfactory component performance. Accordingly, thermal switches were developed to conduct heat away from temperature-sensitive components while heat-generating components were operating during the lunar day, and to retain heat at night when the equipment was off. Author

N67-36216*# Lockheed Missiles and Space Co., Sunnyvale, Calif.
THE INTEGRATED ROCKET SPIN-UP LAUNCH MECHANISM
John Hilan *In* JPL 2d Aerospace Mech. Symp. 15 Aug. 1967 p 101–110 (See N67-36203 21-31)

The integrated rocket spin-up launch mechanism is designed to ignite, spin, and launch a small rocket-propelled payload. It is unique in that several pyrotechnic and mechanical events are initiated by one electrical signal. The mechanism offers an extremely lightweight and compact system for the variety of functions performed, by taking advantage of integrating pyromechanical features provided by the rocket motor configuration. Test flights have proved all aspects of the mechanism operation to be completely successful. Author

N67-36222*# Hughes Aircraft Co., Los Angeles, Calif.
DESPINNING THE ATS SATELLITE
J. P. Dallas *In* JPL 2d Aerospace Mech. Symp. 15 Aug. 1967 p 147–154 refs (See N67-36203 21-31)

The ATS synchronous gravity-stabilized spacecraft is designed to be despun by a two-stage yo-yo in combination with a nutation damper. The unique advantage of the ATS despin mechanism arises from the use of a two-stage yo-yo system in which the off-axis rate errors of the first stage, starting from 100 rpm, are damped out by a nutation damper prior to releasing the second-stage yo-yo, starting from 10 rpm. Author

N67-36225*# Lockheed Missiles and Space Co., Sunnyvale, Calif.
SELF-DESTRUCT CHARGE ORDNANCE COMPONENT OF THE AGENA D VEHICLE SELF-DESTRUCT SYSTEM
Allan Howard Smith *In* JPL 2d Aerospace Mech. Symp. 15 Aug. 1967 p 171–181 refs (See N67-36203 21-31)

The self-destruct charge ordnance component of the destruct system launched with the Agena D satellite vehicle is briefly described. Emphasis is placed on design philosophy, flight performance criteria, and testing techniques. Results of simulated vehicle destruction tests are compared with data from an actual flight destruction of an Agena D vehicle. The self-destruct charge is also compared with two similar ordnance components used for liquid-propellant destruct systems. Author

N67-36556*# IIT Research Inst., Chicago, Ill.
PRELIMINARY PAYLOAD ANALYSIS OF AUTOMATED MARS SAMPLE RETURN MISSIONS
John C. Niehoff May 1967 147 p refs
(Contract NASr-65(06))
(NASA-CR-84849; IITRI-M13) CSCL 22B

The study objective was to identify by preliminary analysis mission modes which could be launched in the mid-1970's by a single Saturn V vehicle using available chemical propulsion systems throughout the mission. Twelve candidate mission modes are formulated from an analysis of many mission phase options. Four of these modes are shown to satisfy study constraints and have payload requirements within the capability of a single Saturn V launch vehicle. Three of the four modes are one year Mars stay time, 975-day round trip missions. They differ in near-Mars orbital maneuvers which are either direct entry/direct escape, out-of-orbit entry/direct escape, or out-of-orbit entry/escape via rendezvous. The fourth possible mode is a 12-day stay time, 550-day round trip mission with a Venus swingby return transfer. The near-Mars orbital maneuvers are out-of-orbit entry/escape via rendezvous. Author

N67-36664# European Space Research Organization, Paris (France).
TECHNICAL STUDY: FACTORS AFFECTING THE DESIGN OF EXPERIMENTAL SYSTEMS FOR TELEVISION DISTRIBUTION BY SATELLITES, PART I, VOLUME II
Jun. 1967 490 p refs
CFSTI: HC $3.00/MF $0.65

The following subjects are examined in detail: The ELDOPAS launch vehicle and the particular features of the type of orbit chosen; the characteristics of the signals to be transmitted and the possibilities and limitations of the ground stations; the different types of possible on-board communications antennas and the variants of on-board receiving and transmitting equipment; attitude control and orbit correction problems; different systems of power supply; thermal equilibrium in a geostationary orbit; and finally the problems of telemetry data transmission and telecommand of the satellite. ESRO

N67-36669# European Space Research Organization, Paris (France).
CONTROL AND STABILIZATION OF SPACECRAFT. VOLUME III: ACTIVE CONTROL SYSTEMS
Jan. 1967 201 p refs Proc. of the 4th ESRO Summer School, Helsingor, Denmark, Aug.–Sep. 1966
(ESRO-SP-18) CFSTI: HC $3.00/MF $0.65

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1. SPACECRAFT ATTITUDE CONTROL: BASIC KINEMATICS AND DYNAMICS W. G. Hughes (Royal Aircraft Establ.) p 1–34 refs (See N67-36670 21-21)
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3. STAR SENSORS P. Haskell (Royal Aircraft Establ.) p 61–88 refs (See N67-36672 21-14)
4. MICROTHRUST PROPULSION B. P. Day (Royal Aircraft Establ.) p 89–108 (See N67-36673 21-28)
5. MICROTHRUST PROPULSION II B. P. Day (Royal Aircraft Establ.) p 109–127 refs (See N67-36674 21-28)
6. ATTITUDE CONTROL BY PURE JET SYSTEMS K. J. O'Mahony (Royal Aircraft Establ.) p 129–154 refs (See N67-36675 21-21)
7. REACTION WHEELS AND GYROS J. K. Abbott (Royal Aircraft Establ.) p 155–170 (See N67-36676 21-14)
8. REACTION WHEEL CONTROL SYSTEMS J. K. Abbott (Royal Aircraft Establ.) p 171–185 refs (See N67-36677 21-14)
9. MOMENTUM UNLOADING SYSTEMS: DESIGN OF MAGNETIC UNLOADING ACTUATORS J. K. Abbott (Royal Aircraft Establ.) p 187–199 refs (See N67-36678 21-03)

32 STRUCTURAL MECHANICS

Includes structural element design and weight analysis; fatigue; thermal stress; impact phenomena; vibration; flutter; inflatable structures; and structural tests. For related information see also: 17 Materials, Metallic; and 18 Materials, Nonmetallic.

N67-35312# Marine Engineering Lab., Annapolis, Md.
AN ENERGY METHOD BASED ON CONTINUUM MECHANICS FOR ACCURATE DETERMINATION OF STRESSES AND DEFLECTIONS OF SUBMARINE HULL AND FOUNDATION STRUCTURES UNDER HYDROSTATIC LOADING
Y. Wang and H. Huang Mar. 1967 88 p refs
(MEL-TM-4/67; AD-654527)

Detailed mathematical theories and computational techniques are described for the development of an experimentally proven computerized energy method which is based on the continuum mechanics and aimed at the accurate determination of stresses and deflections of a typical submarine hull and foundation structures

under hydrostatic loading. The procedure is extended, briefly, for dealing with dynamic loadings as well as the effects of nonlinearities resulting from large structural deflections and/or plastic flow. TAB

N67-35350*# Pratt and Whitney Aircraft, East Hartford, Conn.
METHODS FOR PREDICTING THERMAL STRESS CRACKING IN TURBINE STATOR OR ROTOR BLADES Summary Report
O. L. Stewart and W. H. Vogel 10 Jul. 1967 115 p ref
(Contract NAS3-7909)
(NASA-CR-54636; PWA-3142) CFSTI: HC $3.00/MF $0.65 CSCL 20K

A test rig was designed and constructed to subject simulated turbine blade specimens to controlled temperature and mechanical cycles and environmental conditions closely simulating aircraft gas turbine conditions. As a basis for prediction calculations, isothermal strain cycling fatigue properties and other physical properties were measured for two alloys. Instrumented specimens in each material and configuration were tested, and the transient and steady state metal temperatures were measured at several chordwise locations at the mid-span section of the specimen for the gas temperature cycles and environmental conditions planned for subsequent fatigue tests. Temperature syntheses were completed for the uncooled solid specimens for the fast and slow acceleration temperature cycles, and for the convectively cooled specimen for the slow acceleration temperature cycles. However, it was found that the uncertainty in the value of the bending moments induced in the specimens was too large to satisfy the requirements. M.G.J.

N67-35351*# Pratt and Whitney Aircraft, East Hartford, Conn.
METHOD OF CALCULATING THE TEMPERATURE DISTRIBUTIONS IN THE SPECIMEN AIRFOILS
F. L. Bruno *In its* Methods for Predicting Thermal Stress Cracking in Turbine Stator or Rotor Blades 10 Jul. 1967 9 p ref (See N67-35350 21-32)

Temperature distribution in the simulated turbine blade specimens was calculated for each test condition and airfoil configuration based on estimated boundary conditions. These estimated conditions of velocity profile, flow conditions, and gas side heat transfer coefficients were obtained from an airfoil pressure profile. Equations are formulated for the steady-state heat balance at each node; the transient temperature distribution; heat transfer coefficients on a cylinder in cross flow, laminar flow, and turbulent flow; the coolant side heat transfer coefficient; and the coolant temperature. A film correlation is used to calculate film temperatures when film cooling is used. M.G.J.

N67-35352*# Pratt and Whitney Aircraft, East Hartford, Conn.
TURBINE AIRFOIL STRESS ANALYSIS COMPUTER PROGRAM
W. H. Vogel *In its* Methods for Predicting Thermal Stress Cracking in Turbine Stator or Rotor Blades 10 Jul. 1967 12 p (See N67-35350 21-32)

The input and output of the computer program are listed, and the basic equations used in the stress analysis, and the material stress-strain analysis are derived. The program, which can be applied to any prismatic shape, has the capability of calculating the normal stress and strain on planes perpendicular to the prism axis, the stress and strain due to arbitrary temperature distributions on planes which are normal to the prism axis, and the stress and strain in the elastic-plastic range. Hysteresis effects are included, along with the effects of an arbitrary applied axial force and bending moments about the two coordinate axes in the plane normal to the axis. It is assumed: (1) The temperature varies over the cross section but is constant with length. (2) Initially plane cross sections remain plane after heating and loading, and the consequent bending and elongation. (3) The stress-strain curve can be represented by a logarithmic curve tangent at the proportional limit to the elastic portion of the actual stress-strain curve and passing through two more points in the plastic portion of the actual curve. M.G.J.

N67-35354*# Pratt and Whitney Aircraft, East Hartford, Conn.
METHODS OF CALCULATING BENDING STRESSES IN SPECIMENS
W. H. Vogel *In its* Methods for Predicting Thermal Stress Cracking in Turbine Stator or Rotor Blades 10 Jul. 1967 6 p (See N67-35350 21-32)

An analytical method is described for obtaining the bending moments at the mid-span section induced by such factors as curvature of the specimen due to thermal gradients when simultaneously subjected to axial loading, eccentricities between the bearing axis and the specimen axis, and flexibility in the test rig and loading mechanism. Bending strains were measured with strain gauges in the upper and lower pull rods. These strains, in turn, were related to the mid-span bending moments. The net mid-span moment was obtained by combining the forementioned with those moments resulting from eccentricities induced by the thermal gradients in the speciman which assumes a curvature in an effort to relieve the resultant thermal strains. The latter component was determined through a relationship incorporating the axial load, specimen length and grip geometry, and the angular rotations of the pull rods. These rotations were determined by using the values calculated in the stress analysis program, as a fixed approximation. These rotations could be more accurately determined by direct measurement. Author

N67-35431# Catholic Univ. of America, Washington, D. C. Stress Analysis Lab.
OPTIMIZATION OF A SLOT END CONFIGURATION IN A FINITE PLATE SUBJECTED TO UNIFORMLY DISTRIBUTED LOAD
A. J. Durelli, V. J. Parks, and S. Uribe Jun. 1967 21 p refs
(Contract Nonr-2249(06))
(Rept.-13; AD-654195)

Two-dimensional photoelasticity is used to determine the distribution of stresses at the ends of a transverse slot symmetrically located in the uniform field of a thin birefringent strip subjected to tension. The ends of the slot are ellipses with different axes ratios, ranging from a flat ellipse to a semi-circle. The stress concentration factors are found for different ratios of the transverse width of the slot to the total width of the tensile specimen. Optimum shapes are given for each ratio of the transverse width of the slot to the total width of the tensile specimen. The results obtained may prove useful in the design of solid propellant grains. Author (TAB)

N67-35447*# Allied Research Associates, Inc., Concord, Mass.
PRESSURE STABILITY OF PROLATE SPHEROIDS
Herbert Becker 4 Nov. 1966 12 p
(Contract NASw-1378)
(NASA-CR-87985; ARA-327-3) CFSTI: HC $3.00/MF $0.65 CSCL 20K

A theoretical investigation of prolate spheroids was conducted using the Donnell type equation for doubly curved shells. The results cover the range from a sphere to a cylinder, and show how the simplified form of Mushtari's relation is approached asymptotically from above within that range. Theory and experiment are shown to be in reasonable agreement for some of the test data available; however, the simplified theoretical approach underestimated the strengths of shells with large axis ratios. Author

N67-35481# Structural Mechanics Associates, Narberth, Pa.
STRUCTURAL OPTIMIZATION OF CORRUGATED CORE AND WEB CORE SANDWICH PANELS SUBJECTED TO UNIAXIAL COMPRESSION
J. R. Vinson and S. Shore Philadelphia, Pa., Naval Air Eng. Center, 15 May 1967 109 p refs
(Contract N156-46654)
(NAEC-ASL-1109; AD-654936)

Rational methods are developed of structural optimization for flat, corrugated core and web core sandwich panels subjected to uniaxial compressive loads. These methods provide a means by which such panels can be designed with minimum weight for a given load index, panel width, panel length, and face and core materials. Methods presented permit a rational material selection by comparing the weights of the optimum construction for several material systems as a function of load index. The methods account for both isotropic or orthotropic face and core materials and various boundary conditions. Author (TAB)

N67-35536# ARO, Inc., Arnold Air Force Station, Tenn.
ANALYTICAL SOLUTIONS FOR A CONTINUUM PARALLEL-PLATE ELECTROSTATIC PROBE
Michael D. High Arnold Eng. Develop. Center, May 1967 75 p refs Submitted for publication
(Contract AF 40(600)-1200)
(AEDC-TR-67-71; AD-654274)

The theory for the flow of a weakly ionized gas through a parallel-plate, continuum, electrostatic probe is developed. The flow is separated into three distinct regions: (a) the inviscid, neutral core where electron conduction maintains the continuity of current between the two plates; (b) the viscous, quasi-neutral boundary layer in which the charged particle flow is similar to ambipolar diffusion; and (c) the one-dimensional, collision dominated, space-charge sheath. Analytical solutions, matched at the boundary of each region, are presented for the electron temperature in equilibrium with the gas temperature and for the electron temperature constant at its free-stream value. A criterion is given which may be used to determine whether electron thermal equilibrium exists through the boundary layer. It is shown that the sheath voltage drop comprises approximately 60 percent of the total plate voltage drop. The results also show a very well defined saturation current for the double probe and that this current is controlled by ion diffusion through the boundary layer. Expressions are developed from the solutions which allow the use of experimental data to determine the free-stream electron density and temperature. Author (TAB)

N67-35548# Columbia Univ., New York.
SCHOOL OF ENGINEERING AND APPLIED SCIENCE. SECOND GRADIENT OF STRAIN IN LINEAR ELASTICITY AND ITS APPLICATIONS Interim Technical Report
Seiichi Iwata (Ph.D. Thesis) Jun. 1967 74 p refs
(Contract DA-31-124-ARO(D)-382)
(AROD-5642-1-MC; AD-654774)

This study is an attempt to apply the Mindlin theory of elasticity, where the energy density is a function of strain and its first and second gradients, to several mathematically tractable problems and to examine and compare the results obtained with the discrete particle theory and with experiment. A simple physically understandable discrete particle theory is developed for a two-dimensional lattice using differences and difference equations in place of derivatives and differential equations. This gives further insight into the Mindlin theory. In the Mindlin theory, some problems associated with cylindrical and spherical surfaces are solved. The Mindlin theory and the discrete particle theory are compared with experiments such as low energy electron diffraction and neutron diffraction studies. Author (TAB)

N67-35561# Aerospace Corp., El Segundo, Calif. Lab. Operations.
SPACE APPLICATIONS OF CRYOGENIC TECHNOLOGY
Robert W. Vance Feb. 1967 19 p refs
(Contract AF 04(695)-1001)
(TR-1001(2710-01)-1; SSD-TR-67-65; AD-654683)

Three areas of cryogenic technology pertinent to space applications are discussed: (1) tank designs for long-term storage, (2) miniaturized liquefaction systems and open-loop solid cryogens for cooling spaceborne sensors and equipment, and (3) cryosorption technology for space simulation chambers. Author (TAB)

N67-35616*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
FLIGHT TEST OF A 30-FOOT-NOMINAL-DIAMETER DISK-GAP-BAND PARACHUTE DEPLOYED AT A MACH NUMBER OF 1.56 AND A DYNAMIC PRESSURE OF 11.4 POUNDS PER SQUARE FOOT
Clinton V. Eckstrom and John S. Preisser Washington, NASA, Sep. 1967 37 p refs
(NASA-TM-X-1451) CFSTI: HC $3.00/MF $0.65 CSCL 01C

A 30-foot (9.1 meter) nominal-diameter disk-gap-band parachute (reference area 707 sq ft (65.7 m^2)) was flight tested with a 200-pound (90.7 kg) instrumented payload as part of the NASA Planetary Entry Parachute Program. A deployment mortar ejected the test parachute when the payload was at a Mach number of 1.56 and a dynamic pressure of 11.4 lb/sq ft (546 N/m^2) at an altitude of 127,500 feet (38.86 km). The parachute reached suspension line stretch in 0.37 second resulting in a snatch force loading of 1,270 pounds (5,650 N). Canopy inflation began 0.10 second after line stretch. A delay in the opening process occurred and was apparently due to a momentary interference of the glass-fiber shroud used in packing the parachute bag in the mortar. Continuous canopy inflation began 0.73 second after initiation of deployment and 0.21 second later full inflation was attained for a total elapsed time from mortar fire of 0.94 second. The maximum opening load of 3,915 pounds (17,400 N) occurred at the time the canopy was first fully opened. The parachute exhibited an average drag coefficient of 0.52 during the deceleration period and pitch–yaw oscillations of the canopy were less than 5°. During the steady-state descent portion of the test period, the average effective drag coefficient was about 0.47 (based on vertical descent velocity and total system weight). Author

N67-35624# Aerospace Corp., El Segundo, Calif.
TRANSVERSE VIBRATIONS OF A SHALLOW SPHERICAL DOME, OCTOBER 1966–JANUARY 1967
M. H. Lock, J. S. Whittier, and H. A. Malcom Jun. 1967 15 p refs
(Contract AF 04(695)-1001)
(TR-1001(2240-30)-11; SSD-TR-67-113; AD-655056)

It is shown that the nondimensional roots of the frequency equation for nonsymmetric transverse vibrations of a clamped-edge shallow spherical dome depend upon a single shell geometric parameter. Numerical values of the frequency parameter are given in tabular and graphical form for an extensive range of shell geometries and mode numbers. A simplified version of the frequency equation is also presented and its accuracy discussed. Author (TAB)

N67-35658# David Taylor Model Basin, Washington, D. C. Structural Mechanics Lab.
HYDROSTATIC AND CYCLIC TESTS OF FOUR, HOLLOW-FILAMENT, GLASS-REINFORCED PLASTIC CYLINDERS WITH TITANIUM HEMISPHERICAL END CLOSURES Final Report
William P. Couch Jun. 1967 29 p refs
(DTMB-2402; AD-654907) CFSTI: HC $3.00/MF $0.65

Two pairs of pressure-hull models were designed to operate at a depth of 20,000 ft and to sustain 5000 cycles to depth without serious loss in structural integrity. Each model consisted of a hollow-filament, glass-reinforced plastic cylinder with two titanium hemispherical end closures. One pair of models was designed to have a safety factor of 1.5 and the other pair to have a safety factor of 2.0; the cylindrical section (not including end buildups) of both models in each pair was designed to have weight-to-displacement ratios of 0.58 and 0.62, respectively. One model from each pair was tested to obtain elastic strain data and the static collapse pressure. The second model from each pair was cyclic tested and then was tested to failure. Both pairs of models met the design requirements. Author (TAB)

N67-35726*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

FATIGUE LIFE UNDER RANDOM LOADING FOR SEVERAL POWER SPECTRAL SHAPES

Sherman A. Clevenson and Roy Steiner Washington, NASA, Sep. 1967 26 p refs

(NASA-TR-R-266) CFSTI: HC $3.00/MF $0.65 CSCL 20K

Each of a number of aluminum-alloy test specimens was loaded by random forces at a constant root-mean-square stress level until rupture occurred. The forces were statistically stationary and Gaussian with a zero mean value. The fatigue life (to rupture) was determined for various values of the following statistical parameters: (a) root-mean-square nominal applied stress, (b) power spectral shape, (c) mean number of zero crossings per unit time, and (c) mean number of peak loads per unit time. The power spectra were varied over a passband of frequency for three spectral shapes either by holding the power constant with frequency or by varying it either directly or inversely proportional to the square of the frequency. The results indicate that the fatigue life was determined principally by the root-mean-square nominal applied stress level. The effects of spectral shape, average number of zero crossings, and average number of peak loads were insignificant in the ranges investigated. The fatigue life, based on the number of effective cycles, of the specimens under random loading was lower by at least an order of magnitude at all stress levels than that of the specimens loaded sinusoidally. Author

N67-35744*# Syracuse Univ. Research Inst., N. Y.

PLANE-STRESS ANALYSIS OF AN EDGE-STIFFENED RECTANGULAR PLATE SUBJECTED TO BOUNDARY LOADS, BOUNDARY DISPLACEMENTS, AND TEMPERATURE GRADIENTS

Chuan-jui Lin and Charles Libove Washington, NASA, Aug. 1967 234 p refs

(Grant NsG-385)

(NASA-CR-864; ME-1065-6704) CFSTI: HC $3.00/MF $0.65 CSCL 20K

A plane-stress analysis is presented for an edge-stiffened isotropic or orthotropic elastic rectangular plate subjected to prescribed loads and prescribed temperature distributions. Along one or more of the edges the stiffeners are assumed to rigidly maintain a prescribed shape (e.g., straight), while the stiffeners along the remaining edges are assumed to have negligible flexural stiffness. All four stiffeners are assumed to be uniform and to possess finite axial stiffness. The plate edges are assumed to be integrally attached to the stiffeners along the originally straight centroidal axes of the stiffeners. The analysis is by means of Fourier series. Numerical results are presented for the specific cases of an isotropic square stiffened plate with one edge, two opposite edges, or all four edges held straight. In all three cases the plate was assumed to have a pillow-shaped temperature distribution. In the second case stretching forces parallel to the non-straight edges were also considered. Author

N67-35756 National Aerospace Lab., Tokyo (Japan).

ULTIMATE AXIAL FORCES OF LONGITUDINALLY STIFFENED PLATE PANELS

Tsuneo Tsuiji 1967 17 p refs In JAPANESE; ENGLISH summary

(NAL-TR-132)

An analytical investigation is presented concerning the ultimate forces of longitudinally stiffened plate panels having large width to thickness ratios (the plate buckles before the ultimate axial strength of the panel is reached), and subjected to combined axial and uniformly distributed lateral loads. This analysis is based on the theory of beams and simple plastic theory. Lateral loads cause a significant reduction in the ultimate axial strength of panels. A large post-buckling strength can be expected for a panel with large plate width to thickness ratios. A comparison between the analytical and test results shows that the approximate ultimate axial strength of panels can be predicted by the method developed in this paper. Author

N67-35758*# Georgia Inst. of Tech., Atlanta.

LIQUID SLOSHING IN ELASTIC CONTAINERS

Helmut F. Bauer, Teh-Min Hsu, and James Ting-Shun Wang Washington, NASA, Sep. 1967 38 p refs

(Grant NGR-11-002-028)

(NASA-CR-882) CFSTI: HC $3.00/MF $0.65 CSCL 20K

The coupled oscillations of containers, partially filled with an inviscid and incompressible liquid, are investigated. The following container configurations are considered: (1) a long, rectangular tank with an elastic bottom, (2) a long, rectangular tank with elastic walls, and (3) a cylindrical tank with an elastic wall. Linear theories are used for the description of the motion of the fluid, and that of the container. Numerical values of the natural frequencies are presented for various liquid heights and tank configurations. Author

N67-35769# California Univ., La Jolla. Dept. of Aerospace and Mechanical Engineering Sciences.

OPTIMAL STRUCTURAL DESIGN FOR GIVEN STIFFNESS IN STATIONARY CREEP

W. Prager Jul. 1967 13 p refs

(Contract N00014-67-A-0109-0003)

(TR-9; AD-654729)

A general method of optimal structural design for given stiffness in stationary creep is illustrated by the special case of a disk of variable thickness that carries given loads along part of its edge and is rigidly supported along the remainder. For a given creep stiffness, that is for a given value of the power of the loads on the velocities of stationary creep, the disk is to use the smallest possible amount of a specified material with known creep properties. Author (TAB)

N67-35771# Naval Ship Research and Development Center, Washington, D. C. Hydromechanics Lab.

GENERAL RESISTANCE TEST OF A STEPPED PLANING HULL WITH APPLICATION TO A HYDROFOIL CONFIGURATION Final Report

Lawrence Benen May 1967 45 p refs

(NSRDC-2320; AD-654900)

General resistance tests of TMB Model 4776, a transverse stepped planing hull, were conducted. The hull is the third model tested to determine suitability for use as a hydrofoil hull. Resistance, trimming moment, and wetted lengths were measured for several load, trim, and speed conditions. All data are presented in nondimensional form for use in comparing hull forms. The tests indicated that the model at high speed coefficients has low moment and resistance characteristics which would be advantageous to a hydrofoil configuration. Although instabilities due to spray and inadequate step ventilation were found, the trim conditions at which these instabilities occur can be avoided during the normal takeoff operation. Author (TAB)

N67-35886# IIT Research Inst., Chicago, Ill. Dept. of Mathematics.
THE CYLINDER PROBLEM IN THERMOVISCOELASTICITY
Warren S. Edelstein May 1967 23 p refs
(Contract N00014-67-A-0210-0001)
(TR-1; AD-655146)

The axially symmetric plane strain problem is solved for a thick-walled hollow viscoelastic cylinder subject to an axially symmetric but otherwise arbitrary temperature field. Three types of boundary conditions are considered: (1) zero displacement of the inner and outer walls, (2) zero traction on both walls, and (3) zero traction inside, zero displacement outside. Author (TAB)

N67-35904# California Univ., Berkeley. Coll. of Engineering.
A STUDY OF THE DYNAMIC STABILITY OF CONTINUOUS ELASTIC SYSTEMS BY LIAPUNOV'S DIRECT METHOD
R. H. Plaut May 1967 131 p refs
(Grant NSF-GK-781)
(AM-67-3)

Liapunov's direct method is used to derive dynamic stability and instability criteria for some elastic and aeroelastic systems. Domains of asymptotic stability are also obtained. The systems considered are continuous and autonomous, and include columns, arches, plates, and shallow shells. Some nonlinear and nonconservative problems are treated. One-dimensional as well as two-dimensional systems are considered. The dynamic stability of columns with various end conditions under axial loading is examined, and stability criteria are derived for rectangular, simply supported plates and curved panels. It is shown that if a plate is stable under a set of uniform biaxial forces, a shallow curved panel with the same dimensions and flexural rigidity would also be stable under those forces. Clamped systems which are investigated include plates and shallow shells under uniform normal forces at the edges. Necessary and sufficient conditions are derived for the dynamic stability of rectangular and circular plates, in addition to sufficient conditions for plates of arbitrary shape, shallow circular shells, and plates in an air stream. Author

N67-36027# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
CYLINDRICAL SHELLS DURING SUPERCRITICAL DEFORMATIONS
A. V. Pogorelov 13 Apr. 1967 89 p refs Transl. into ENGLISH of the book "Tsilindricheskiye Obolochki pri Zakriticheskikh Deformatsiyakh" Kharkov, Izd. Khar'kovsk. Univ., 1963 p 1-92
(FTD-MT-65-176; TT-67-62276; AD-655017)

An investigation was made of the supercritical elastic state of thin shells after loss of stability. A new prospective method of investigation and calculation of shells is developed. A solution is presented in closed form of a series of difficult problems of the contemporary theory of shells. The account is basically elementary. TAB

N67-36028# National Aerospace Lab., Tokyo (Japan).
EXPERIMENTAL AND CALCULATED RESULTS OF SUPERSONIC FLUTTER CHARACTERISTICS OF A LOW ASPECT-RATIO FLAT-PLATE SURFACE
Eiichi Nakai, Toshiro Takagi, Koti Isogai, and Toshiyuki Morita Jan. 1967 12 p refs
(NAL-TR-125T)

An experimental investigation of the supersonic flutter characteristics of thin cantilever plate surfaces having a plate aspect-ratio of 1.0 and a taper ratio of 0.63 has been conducted in a supersonic blow-down wind tunnel at Mach numbers from 1.519 to 4.140. Each model was cantilevered on the side wall of test section of the wind tunnel with a model injection-rejection rig. The experimental results were compared with the calculated results employing piston theory and quasi-steady second-order theory as the required oscillatory aerodynamic forces and utilizing the first three normal coupled modes which include cambering deflections. Both theories were unconservative for the configuration of the models experimented and the range of Mach numbers investigated. Author

N67-36060*# Bolt, Beranek, and Newman, Inc., Cambridge, Mass.
STRUCTURAL RESPONSE TO INFLIGHT ACOUSTIC AND AERODYNAMIC ENVIRONMENTS
K. L. Chandiramani, S. E. Widnall, R. H. Lyon, and P. A. Franken 31 Jul. 1966 138 p refs
(Contract NAS8-20026)
(NASA-CR-88211; Rept.-1417) CFSTI: HC $3.00/MF $0.65 CSCL 20K

Acoustic and aerodynamic noise environments experienced by a typical launch vehicle are classified and reviewed for application to a study of those aspects (range of trajectory and geometric parameters e.g.) of the environments which enter directly into interactions with the structural components of the vehicle. The noise sources, and mathematical models for appropriate representation of these noise sources are described. Various dynamical properties of two idealized structures, a cylinder and a flat plate, are presented. Dynamical properties discussed are: pressure-to-velocity wave admittance, modes and representation of modal oscillators, resonance frequencies of modes, modal density, radiation resistance of modes, and resulting radiation loss factors. Statistical calculations for estimating average values of surface acceleration and stress level in frequency bands are presented. L.S.

N67-36070# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.
THE THERMAL STRESSES IN A THICK-WALLED CONE BY THE METHOD OF FINITE DIFFERENCES
Roger O. Weiss May 1967 59 p refs
(Contract NOw-62-0604-c)
(TG-914; AD-655461)

A thick-walled cone subject to arbitrary axisymmetric thermal gradients is analyzed. The displacements and stresses are determined by a computer program which is predicated on the method of finite differences. A special direct method is utilized to solve the matrix equation. The program is used to analyze two check problems which produce an unrestrained expansion of the cone. The results for a linear temperature gradient, uniform along the length of the cone, are presented and compared to thin-shell and thick-walled cylinder calculations. The results indicate that a tensile stress concentration occurs at the inside apex of the cone. Author (TAB)

N67-36128# Nationaal Lucht-en Ruimtevaartlaboratorium, Amsterdam (Netherlands). National Aerospace Lab.
FATIGUE TESTS WITH RANDOM AND PROGRAMMED LOAD SEQUENCES, WITH AND WITHOUT GROUND-TO-AIR CYCLES. A COMPARATIVE STUDY ON FULL-SCALE WING CENTER SECTIONS
J. Schijve, D. Broek, P. de Rijk, A. Nederveen, and P. J. Sevenhuysen *In its* Rept. and Transl., Vol. 32 1967 52 p refs Prepared for AFEOAR and Neth. Aircraft Develop. Board (See N67-36124 21-14)
(NLR-TR-S.613)

Fatigue tests were carried out on full-scale tension skins of a wing center section of 7075-T6 material. Variable amplitude tests were carried out with the following load sequences: random load, program load, random load with GTAC (ground-to-air cycles), and program load with GTAC. Constant-amplitude tests were carried out with GTAC and gust amplitudes. The main objectives were to investigate (1) the equivalence of random and program loading, (2) the damping effect of GTAC, and (3) recommendations for full-scale testing. Results obtained are related to the indication of fatigue-critical components, fatigue lives, crack propagation, residual strength, $\Sigma n/N$-values, scatter, and inspection methods.

Relevant information of the literature is summarized. Recommendations for full-scale testing are concerned with the indication of the loads to be incorporated into the test, the assessment of load spectra, the highest loads to be applied, the smallest load fluctuations to be included, the load sequence to be adopted, the duration of the test, and experimental conditions. Author

N67-36183# West Virginia Univ., Morgantown. Coll. of Engineering.
VIBRATION STUDY OF ROTATING MACHINERY TO AID IN SHIPBOARD VIBRATION PROBLEMS Final Technical Report
30 Jun. 1967 115 p refs
(Contract Nonr-3256(02))
(AD-654196)

A mathematical model was made of a piece of rotating equipment to determine the vibration characteristics of the actual machine and to determine how such vibrations might be controlled, thus leading to quiet operation on shipboard. A 64 KW, Allis-Chalmers motor-generator set, of the type commonly used by the Navy, was selected for developing the mathematical model. Both digital and analog computers were used to study the machines vibration characteristics and both computers gave substantially the same results. Author (TAB)

N67-36201# Ballistic Research Labs., Aberdeen Proving Ground, Md.
THE DYNAMIC EXPANSION OF A SPHERICAL CAVITY IN AN ELASTIC-PERFECTLY-PLASTIC MATERIAL
Chi-hung Mok Feb. 1967 38 p refs
(BRL-1357; AD-654369)

It was shown that a finite-difference numerical technique can be used to solve mixed initial- and boundary-value problems involving high-speed elastic-plastic flow with spherical symmetry. Numerical solutions for the dynamic expansion of a spherical cavity under a constant pressure are presented to demonstrate the nature and capability of the numerical scheme. The solution for an elastic material agrees closely with the exact solution. The solution for an elastic-perfectly-plastic material confirmed Greens prediction concerning the motion of the elastic-plastic boundary. At large times, the asymptotic solution of the dynamic problem is different from the quasi-static solution. This result indicates that the quasi-static approximation may not hold in dynamic plasticity. A non-linear dependence of the plastic solution on the boundary condition is also observed in the results. Author (TAB)

N67-36221*# De Havilland Aircraft Co., Ltd., Malton (Ontario).
THE BI-STEM—A NEW TECHNIQUE IN UNFURLABLE STRUCTURES
J. D. MacNaughton, H. N. Weyman, and E. Groskopfs *In* JPL 2d Aerospace Mech. Symp. 15 Aug. 1967 p 139–146 refs (See N67-36203 21-31)

The BI-STEM is a development of the storable tubular extendible member (STEM), which is used for erecting unfurlable structures in space. The BI-STEM is described, and data are presented on the analytical and structural characteristics of this mechanism. Author

N67-36224*# Boeing Co., Kent, Wash.
NEW CLOSED TUBULAR EXTENDIBLE BOOM
Bruce B. Rennie *In* JPL 2d Aerospace Mech. Symp. 15 Aug. 1967 p 163–170 refs (See N67-36203 21-31)

The MAST (multiple applications storable tube) is a closed, collapsible tube that may be used to transport fluid and transmit torque, in addition to the other functions performed by currently used extendible booms. Data are presented to serve as a design guide, and the development work is described. Author

N67-36390 Lockheed Missiles and Space Co., Sunnyvale, Calif.
STABILITY OF A COMPRESSED CYLINDRICAL SHELL OF ELLIPTIC CROSS-SECTION
I. N. Ginzburg [1967] 6 p refs Transl. into ENGLISH from Prikl. Mekh., Akad. Nauk Ukr. RSR (Kiev), v. 3, no. 5, 1967 p 126–130

A geometrically linear formulation is presented to solve the problem of the stability of a cylindrical shell of elliptic cross section subjected to an axial compressive loading. Author

N67-36412# Aerospace Corp., El Segundo, Calif. Labs. Div.
EXPERIMENTS ON THE SNAPPING OF A SHALLOW DOME UNDER A STEP PRESSURE LOAD
M. H. Lock, S. Okubo, and J. S. Whittier Jun. 1967 50 p refs
(Contract AF 04(695)-1001)
(TR-1001(2240-30)-8; SSD-TR-67-117; AD-655057)

The dynamic step pressure loads required to produce snapping are determined experimentally for two shallow spherical shell models. The resulting critical step pressures are compared with static buckling pressures that were obtained from the results of a nondestructive buckling test. The comparison reveals that the critical step pressures were between 55 and 58% of the static buckling pressure for one model and between 63 and 64% of the static buckling pressure for the other model. The measured supercritical response of the shells was similar to the predictions of theory. Author (TAB)

N67-36440 Lockheed Missiles and Space Co., Sunnyvale, Calif.
PLANE STRAIN IN THE ASYMMETRIC THEORY OF ELASTICITY [PLOSKAIA DEFORMATSIIA V ASIMMETRICHESKOI TEORII UPRUGOSTI]
A. N. Bulygin and E. V. Kuvshinskii [1966] 7 p refs Transl. into ENGLISH from Prikl. Mat. i Mekh. (Moscow), v. 31, no. 3, 1967 p 543–547

Fundamental equations of plane strain are given, and are solved by introducing terms of a fourth and second order function, needing no additional compatibility. A complex representation of the solution is given, and the problem of separation of the boundary conditions is formulated. Examples of boundary value problems for the separation of the boundary conditions for half-plane are also given. L.S.

N67-36494# Materials Research Lab., Inc., Richton Park, Ill.
INTERPHASE FRACTURING OF COMPOSITE BODIES Final Report, Apr. 1–Dec. 31, 1966
Sheldon Mostovoy and E. J. Ripling Jun. 1967 42 p refs
(Contract NOw-66-0539-c)
(AD-655138)

Cracking location for short time tests in the Dow epoxy resin (DER) 332, TEPA adhesive was found to depend on composition. At specific ratios of resin to hardener the crack path changed from center of bond (CoB) to interface (IF), depending on adherend material and surface treatment. For compositions where CoB fractures predominate, pre-cracked specimens exposed at zero stress, to either atmospheric humidity or liquid water, showed reinitiation toughness values higher than those seen in prior running or subsequent extension. This toughening is probably a result of the compressive stresses developed in the epoxy by water absorption around the crack tip. Static fatigue exposure of normally CoB pre-cracked specimens was found to cause significant slow crack extension at loads well below those required for rapid extension in short time tests. Debonding occurred starting at one IF directly in line but separated from the pre-existing crack. Propagation rates increased as either applied load or humidity was increased.

Dynamic fatigue exposure of similarly CoB pre-cracked specimens also showed slow IF crack extension from the initial flaw. Rates of crack extension per cycle for this loading condition were found to be linear, increasing as stress amplitude or humidity was increased. Effects of a given maximum load and humidity were much more severe in the dynamic fatigue case than in the static. Author (TAB)

N67-36501 Joint Publications Research Service, Washington, D. C.
ACOUSTICAL MEASUREMENTS IN SHIPBUILDING
I. I. Klyukin and A. Ye. Kolesnikov 1 Sep. 1967 97 p refs Transl. into ENGLISH from the book "Akusticheskiye Izmereniya V Sudostroyenii" Leningrad, Sudostroyeniye, 1966
(JPRS-42402; TT-67-33031) CFSTI: $3.00

Sonic vibrations of structures and mechanisms were measured in a study of acoustical measurements in shipbuilding. Also considered were the vibration sensor readings and the oscillation energy radiated by mechanisms to supporting connections. A spectral analysis and visualization of oscillatory process were performed. Measurements of vibration insulation and vibration absorption were made. Such factors as the elastic gaskets, shock absorbers, the mechanical line, and the insulating effect on impact shocks by connected vibration absorbers were considered. The dynamic constants of elastoviscous materials and gaskets made of such materials were examined. Measurements were also made of the mechanical resistance of structures against forward displacements and against turning displacements. S.P.

N67-36559* General Electric Co., Schenectady, N. Y. Missile and Space Div.
RE-ENTRY "F" NOSE VIBRATION AND SHOCK TEST Final Report
M. Most Jul. 1967 89 p
(Contract NAS1-6039)
(NASA-CR-66467; Doc.-67SD942) CSCL 20K

The nose was mounted in a manner which simulates actual spacecraft mounting. Vibration surveys were made with input in the roll axis and one lateral axis direction. Shock tests were performed with input in the roll axis only. Input levels were based on analytical predictions. Results are summarized and test data graphs and charts are presented. Author

N67-36564*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
DYNAMIC MODEL INVESTIGATION OF WATER PRESSURES AND ACCELERATIONS ENCOUNTERED DURING LANDINGS OF THE APOLLO SPACECRAFT
Sandy M. Stubbs Washington, NASA, Sep. 1967 45 p refs
(NASA-TN-D-3980) CFSTI: HC $3.00 CSCL 22B

An experimental investigation determined impact water pressures, accelerations, and landing dynamics of a 1/4-scale dynamic model of the Apollo spacecraft command module. A scaled-stiffness aft heat shield simulated the structural deflections of the full-scale heat shield. Tests were made on water to obtain impact pressure data at a simulated parachute letdown, and additional tests were made on water, sand, and hard clay-gravel landing surfaces. Maximum mean water pressures were obtained, as well as the mean pressure at the time of maximum acceleration. Normal accelerations for water landings showed pronounced oscillations due to heat-shield vibration. The vehicle occasionally turned over for landings in water at a 0° roll attitude, but a 180° roll attitude gave improved stability with no turnover. The vehicle was found to float stably in an upright as well as in a near inverted attitude. Additional landings investigated on water, sand, and hard clay-gravel composite surfaces resulted in maximum normal accelerations of 30g, 49g, and 42.5 g, respectively. Heat-shield failure occurred for all tests but one made on sand and for all tests made on the hard clay-gravel landing surfaces. Author

N67-36655# Southwest Research Inst., San Antonio, Tex.
STUDIES OF THE FATIGUE STRENGTH OF PRESSURE VESSELS. CYCLIC PRESSURE TESTS OF LARGE SIZE PRESSURE VESSELS. FAST FRACTURE TESTS OF ONE-HALF SCALE PRESSURE VESSELS. EFFECT OF WELD DEFECTS ON THE FATIGUE STRENGTH A302B STEEL Progress Report, Oct. 1, 1966–Jan. 1, 1967
A. G. Pickett and S. C. Grigory 24 Feb. 1967 21 p
(Contract AT(11-1)-1228)
(SWRI-1228P1-37; SWRI-1228P5-35; SWRI-1228P2-35; PR-21) CFSTI: HC $3.00/MF $0.65

Results are presented of destructive tests on steel pressure vessels. Cyclic pressure tests were made on large size pressure vessels, 36 in. ID of 2 in. wall thickness, and fast fracture tests on one-half scale vessels. Tests were also made to determine the effects of weld defects on the fatigue strength of A302B steel. NSA

33 THERMODYNAMICS AND COMBUSTION

Includes ablation, cooling, heating, heat transfer, thermal balance, and other thermal effects; and combustion theory. For related information see also: 12 Fluid Mechanics; and 27 Propellants.

N67-35385# Oak Ridge National Lab., Tenn.
AN EVALUATION OF RECENT STUDIES OF HIGH-FLUX HEAT TRANSFER TO GASES
W. R. Gambill 24 May 1967 25 p refs
(Contract W-7405-ENG-26)
(ORNL-TM-1877) CFSTI: HC $3.00/MF $0.65

A review was made of the literature of the past decade in order to collect quantitative information relevant to the transmission of heat to flowing gases at high heat fluxes (defined here as a maximum experimental flux of at least 0.5×10^6 Btu/hr-ft^2). The available data include heat-transfer-coefficient determinations for He, H_2, and N_2 in tubular, parallel-plate, and wire-mesh geometries for pressures of 15 to 1511 psia, Reynolds numbers of 2.0×10^2 to 1.5×10^6, maximum heat fluxes of 0.58×10^6 to 7.68×10^6 Btu/hr-ft^2, and maximum surface and bulk coolant temperatures of 5440°F and 4180°F, respectively. The correlations proposed for heat-transfer coefficients are reviewed and a recommendation made for turbulent internal duct flow. Graphical results are given which directly relate surface temperature to heat flux for helium flowing through a 0.5-in.-diam tube at mass velocities of 10^4 to 10^6 lb/hr-ft^2 and at bulk temperatures of 200 to 4000°R. Friction data are also reviewed and a correlation recommended for the computation of friction factors up to a temperature ratio of ≈8. Author (NSA)

N67-35395*# Mississippi State Univ., State College. Dept. of Mechanical Engineering.
VIBRATION EFFECTS ON HEAT TRANSFER IN CRYOGENIC SYSTEMS Annual Report, 1 Jun. 1966–30 Jun. 1967
E. H. Bishop, C. J. Bell, C. T. Carley, T. T. Crow, R. E. Forbes et al 30 Jun. 1967 106 p refs
(Contract NAS8-20284)
(NASA-CR-87996; ARP-1) CSCL 20M

A fundamental analytical study was undertaken to determine if a theory could be evolved which would predict the effects of intense mechanical vibrations on the transport properties of a fluid. A mathematical model was constructed for the laminar two-dimensional natural convection of a fluid enclosed between two plane parallel vertical boundaries which are held at different uniform temperatures. In deriving the governing equations, it is assumed that the enclosed fluid under thermal equilibrium conditions moves as a bulk when the enclosure is vibrated. Finite difference techniques are used for the solution. An experimental test cell, with air or water as the test fluid, was constructed for a rectangular cross section enclosure with directly opposing isothermal vertical walls. Heat transfer data in a nonvibratory mode were obtained for one aspect ratio and various values of the Rayleigh number. Results show that the apparatus will yield high integrity data. Theoretical investigations were initiated to study vibration effects on the properties of a cryogenic fluid. An annotated bibliography resulting from a literature survey is included. M.G.J.

N67-35425 Joint Publications Research Service, Washington, D. C.

THE PHENOMENON OF DETONATION

A. S. Kompaneyets *In its* Probl. in Chem. Phys. 22 May 1967 p 16–19 (See N67-35421 21-06)

Shock wave formation, propagation, velocity, and use in detonation systems are considered. Development efforts associated with nuclear and thermonuclear reactions using detonating waves are reviewed. E.C.

N67-35474 Joint Publications Research Service, Washington, D. C.

POWER PARAMETERS OF THE SOLAR CONCENTRATOR OF THE SV-1 WATERLIFT UNIT

D. I. Teplyakov, R. R. Aparisi, Ya. G. Kolob, R. A. Zakhidov, and A. Annayev *In its* Res. in Solar Eng. 24 May 1967 p 22–28 refs (See N67-35470 21-03)

Calorimetric tests of the reflector for a solar waterlifting installation constructed in the Krzhizhanovskiy Power Institute are discussed. The results of these tests serve as a basis for the design of semiconductor thermogenerators. Author

N67-35475 Joint Publications Research Service, Washington, D. C.

THERMOELECTRIC PARAMETER MEASUREMENT TECHNIQUE

Ya. Agayev and A. R. Mikhaylov *In its* Res. in Solar Eng. 24 May 1967 p 29–37 refs (See N67-35470 21-03)

The technology of measurement of conductivity, differential thermoelectric power, and thermal conductivity at large temperature intervals using contrary directions of heat flow is discussed. We have measured the thermoelectric power, thermal conductivity of mineral FeS_2 and AlSb monocrystals of the p- and n-type over a large temperature range. It is shown that the thermal conductivity changes with temperature according to the $\varkappa \approx T^{-1}$ law. Thermal conductivity is caused mainly by heat transport by phonons. Author

N67-35487# Massachusetts Inst. of Tech., Cambridge. Dept. of Mechanical Engineering.

HEAT TRANSFER AND PRESSURE DROP IN TAPE GENERATED SWIRL FLOW

Robert F. Lopina and Arthur E. Bergles Jun. 1967 150 p refs
(Contract F44620-67-C-0047)
(TR-70281-47; AD-654739)

Improvements in heat transfer for equal flow rates of up to 85% were observed for the non-boiling swirl flows with heating, but the improvement with cooling was substantially less. Compared on the basis of equal pumping power, improvements in heat transfer of up to 35% were observed for the tighter tape twists. A method for predicting the heat transfer coefficient for non-boiling swirl flows was developed. The surface boiling characteristics of swirl flow were found to be similar to those observed in straight flow. The boiling curves for various velocities were asymptotic to a fully developed line at high wall superheats, and the visually observed point of incipient boiling and the transition to the fully developed boiling asymptote were predictable by conventional straight flow methods. It was concluded, therefore, that the dominant surface boiling heat transfer mechanism was similar for both swirl and straight flow. For non-boiling swirl flows, the decrease in the pressure drop with heating was slightly less than is usual with straight flows, while the increase in the pressure drop with surface boiling was substantially less. A method for predicting the difference in each case is presented. Author (TAB)

N67-35527*# National Bureau of Standards, Boulder, Colo. Cryogenics Div.

COMPUTER PROGRAMS FOR THERMODYNAMIC AND TRANSPORT PROPERTIES OF HYDROGEN

W. J. Hall, R. D. McCarthy, and H. M. Roder 18 Aug. 1967 188 p refs
(NASA Order R-45)
(NASA-CR-88086; NBS-9288) CSCL 20M

The range of the programs extends from 1 to 5000 psi for temperatures from the triple point to 5000°R or for enthalpies from −130 BTU/lb to 20,000 BTU/lb. The programs provide 18 combinations of input and output variables. Input variables are the pairs pressure/temperature and pressure/enthalpy. Output variables are enthalpy or temperature, density, entropy, thermal conductivity, viscosity, velocity of sound, heat capacity at constant pressure, heat capacity at constant volume, and the heat capacity ratio. Each program achieves high speed by using linear interpolation in a grid of selected points which define the surface of the property returned. The maximum errors arising from the linear interpolation and the errors inherent in the primary sources of data are shown. Author

N67-35694# Army Weapons Command, Rock Island, Ill. Research and Engineering Div.

THERMAL STABILITY AT 75°F OF HIGH TEMPERATURE FLUIDS AND FLUID INTERMIXTURES

Ralph L. LeMar Apr. 1967 25 p refs
(RIA-TR-67-1105; AD-654797)

The thermal stability of six high temperature fluids and twelve of their most stable intermixtures was evaluated at 750F for a period of six hours under nitrogen in the presence of copper, titanium, steel and monel metal specimens. When each of the six fluids was tested individually, polyphenyl ether and phenyl methyl polysiloxane displayed outstanding stability. A chlorinated biphenyl fluid was moderately stable but was corrosive to several metals. Diphenyl bis-n-dodecyl silane, tetra (2-ethyl-hexyl) ortho silicate and deep dewaxed, super refined mineral oil all underwent severe degradation. Among the fluid intermixtures, five displayed good to moderate thermal stability. These generally consisted of combinations of the three most stable fluids. Most mixtures containing the silicate and mineral oil fluids as well as these two fluids when tested separately, could be ignited at room temperature after exposure to 750F. The metals most resistant to fluid attack were copper and titanium. Author (TAB)

N67-35645# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

PROBLEM OF CALCULATING HEAT EXCHANGERS WITH INTERNAL SOURCES AND HEAT EFFLUENCES [K VOPROSU RASCHETA TEPLOOBMENNIKOV S VNUTRENNIMI ISTOCHNIKAMI I STOKAMI TEPLA]

Yu. I. Danilov, B. M. Galitseyskiy, and N. I. Shuvanov 21 Feb. 1967 16 p refs Transl. into ENGLISH of the publ. "Issledovaniye Teploobmena v Potokakh Zhidkosti i Gaza" Moscow, Izd-Vo Mashinostroyeniye, 1965 p 126–136
(FTD-HT-66-428; TT-67-62273; AD-655013)

Approximate computational formulas are derived for the case of a plate-like element. Formulas are also given for the temperature distribution within a multilayer wall with internal heat sources and sinks. The method of point sinks permits simple calculations of even the most complicated heat exchange devices with internal sources and sinks. However, the method supplies sufficient accuracy only in the case of a sufficiently small size of the relative hydraulic diameter. TAB

N67-35646# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
THERMODYNAMIC PROPERTIES OF AN AZEOTROPIC FREON-22 AND FREON-115 MIXTURE
I. S. Badyl'kes 23 Feb. 1967 12 p refs Transl. into ENGLISH Kholodil. Tekhn. (Moscow), no. 5, 1964 p 41–46
(FTD-HT-66-452; TT-67-62274; AD-655014)

An azeotropic mixt. of Freon-22, 48.8%, and Freon-115, 51.2%, has a B.P. of −45.6C, its vol. cooling power is considerably higher than that of Freon-12, Freon-22, and Freon-115. This mixt. is neither explosive nor toxic. Two equations for calculating the vapor pressure were used: LN P = A + (100 B/T) + C LN (T/100) −D(T/100) to the 6th power and P = (RT/V double prime) + +((C'T −F')/V double prime sq.) + ((A'T−B')/V double prime sq.), where P is the pressure in atm. ABS., A = 7.246308, B = −13.738168, C = −3.3686219, D = −0.000048709009, P is the pressure in KG./sq. M. ABS., V double prime is the SP. vol. of dry stad. vapor, A' = −0.000006274858, B' = −0.0044939876, C' = 029740256, F' = 15.951252, R = 7.5920074, and T is the temp. in degrees K. In the temp. range from 203.16 to 323.16K, the max. deviation between the pressure values obtained from these equations was 0.09%. Thermodynamic properties and SP. vols. of the super-heated vapor are given. The mixt. may be used in industrial equipment design for operation with NH3 and Freon-22. TAB

N67-35666*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
GASEOUS-HYDROGEN–LIQUID-OXYGEN ROCKET COMBUSTION AT SUPERCRITICAL CHAMBER PRESSURES
Martin Hersch and Edward J. Rice Washington, NASA, Sep. 1967 31 p refs
(NASA-TN-D-4172) CFSTI: HC $3.00/MF $0.65 CSCL 21B

The effect of wide variations in chamber pressure on rocket combustor performance was determined. A series of combustors with two different contraction ratios, 2, and 10, was used to cover a nominal chamber pressure range of approximately 300 to 1800 psia at a thrust range of 100 to 200 pounds force. The nominal oxidant-fuel mixture ratio was 2.3. Chamber length was varied from 2 to 10 inches at each pressure level. The chamber pressure was increased by increasing the propellant flow rate and by decreasing the nozzle throat area at a constant contraction ratio. Performance efficiencies for the combustor with a low contraction ratio increased with increasing chamber pressure, while those combustors with a high contraction ratio decreased with increasing chamber pressure. These apparently contradictory results were explained by using both an experimental drop size correlation that indicates drop size increases with increasing chamber pressure and a vaporization model with flash vaporization in the nozzle. The analysis of the contradictory results indicated that the calculated characteristic exhaust velocity performance based on the static chamber pressure can exceed 100 percent. This performance is possible because of the large total pressure loss that occurs with burning in the nozzle near the throat. Author

N67-35667*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EXPERIMENTAL HEAT-TRANSFER STUDY OF A REGENERATIVELY COOLED HYDROGEN–FLUORINE ROCKET ENGINE AT LOW CHAMBER PRESSURE
Arthur N. Curren, Harold G. Price, Jr., Roger C. Krueger, and Frank L. C. Manning Washington, NASA, Sep. 1967 68 p refs
(NASA-TN-D-4178) CFSTI: HC $3.00/MF $0.65 CSCL 21H

The chambers were operated at a combustion pressure of about 60 pounds per square inch absolute and propellant mixtures of about 12, 15, and 18 percent hydrogen by weight, yielding a nominal thrust level of 1000 pounds at sea-level conditions. The nozzle throat design diameter was 3.910 inches, and design contraction and expansion ratios were 1.897 and 3.679, respectively. The chambers were of cylindrical, right-conical construction, and the cooling system was such that the incoming fuel (hydrogen) was ducted in a jacket along the nozzle and combustion zone external surfaces from nozzle exit to injector in a single pass. Injectors used were of multielement coaxial design and had been developed to yield smooth high-performance operation with the thrust chambers used in this investigation. Local combustion gas-to-wall and wall-to-constant heat-transfer rates and coefficients as well as coolant pressure-loss characteristics were determined by data analysis. This information made possible the derivation of appropriate constants for modifications of a dimensionless heat-transfer correlation for local application. In addition, the coolant friction pressure-loss factors were compared with the values predicted by means of a familiar smooth-tube correlation. Author

N67-35691# RAND Corp., Santa Monica, Calif.
THE THERMODYNAMICS OF THE GRAPHITE–CARBON VAPOR SYSTEM
F. J. Krieger Jun. 1967 38 p refs
(Contract F44620-67-C-0045; Proj. RAND)
(RM-3326-2-PR; AD-655074)

The thermodynamic investigation of graphite covers a range of temperatures up to 6000K and pressures up to 1000 atmospheres. Two sets of equilibrium composition equations are used--one representing a pure gas phase (including nine ionized chemical species), the other a heterogeneous system of gas and solid carbon. The results of the computational program are presented in both tabular and graphic form. The latter is a conventional Mollier diagram in which specific enthalpy is plotted against specific entropy, with cross plots of temperature, pressure, molecular weight, and moles of condensed carbon. Author (TAB)

N67-35729*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
EFFECTS OF A SIMULATED SPACE ENVIRONMENT ON THERMAL RADIATION CHARACTERISTICS OF SELECTED BLACK COATINGS
William R. Wade and Donald J. Progar Washington, NASA, Sep. 1967 66 p refs
(NASA-TN-D-4116) CFSTI: HC $3.00/MF $0.65 CSCL 20M

Black coatings were prepared by various processes for possible use as stable, highly absorbing surfaces for spacecraft or as flat absorbers for use in ground-test space-simulation facilities in the wavelength range from 0.25 μm to 25.0 μm. The coatings were subjected to a simulated space environment of simultaneous high vacuum and intense ultraviolet radiation, and then to high-energy electron radiation. The coatings were also subjected to simulated micrometeoroid impact (erosion). The results of this investigation indicate that most of the black coatings experienced only negligible change of thermal radiation characteristics due to exposure to the simulated space environment. The only changes of solar absorptance noted were on the anodized aluminum samples dyed by use of

commercial organic dyes and the inorganic compounds of bismuth sulfide and lead sulfide. Slight changes of thermal emittance were detected for the bismuth sulfide and nickel sulfide anodized aluminum and for the sodium dichromate blackened inconel. The greatest change of thermal emittance, 12.9 percent, was experienced by the black nickel plate. Author

N67-35764*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

ESTIMATES OF LOCAL AND AVERAGE FUEL TEMPERATURES IN A GASEOUS NUCLEAR ROCKET ENGINE

Albert F. Kascak Washington, NASA, Sep. 1967 31 p refs
(NASA-TN-D-4164) CFSTI: HC$3.00/MF$0.65 CSCL 21F

A diffusion analysis is presented of the radiant heat transfer from a centrally located cylinder of gaseous nuclear fuel to a surrounding annulus of flowing hydrogen. The specific reactor analyzed had a cavity length of 6 feet (1.83 m), a cavity diameter of 8 feet (2.44 m), and a fuel diameter of 3.2 feet (0.975 m). Results are shown as radial temperature profiles and integrated average temperatures in the fuel region. Parametric calculations are presented to show the influence on fuel temperature of boundary conditions, radial fuel profiles, fuel ionization and density profiles, the fuel absorption coefficient, reactor pressure, and engine thrust. All calculations are for a specific impulse of 1500 seconds; engine thrust is varied from 10^5 to 10^6 pounds (4.45×10^5 to 4.45×10^6N), which corresponds to reactor powers from 4,000 to 40,000 megawatts. Most results are presented for a thrust of 500,000 pounds (2.22×10^6N) and a reactor pressure of 500 atmospheres (5.07×10^7 N/m^2), but a final set of average fuel temperatures are also presented for pressures of 100, 500, and 1000 atmospheres (1.01×10^7, 5.07×10^7, and 10.1×10^7 N/m^2) and a thrust ranging from 10^5 to 10^6 pounds (4.45×10^5 to 4.45×10^6 N). Author

N67-35776*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

THERMODYNAMIC PROPERTIES OF POTASSIUM TO 2100°K

Sheldon Heimel Washington, NASA, Sep. 1967 40 p refs
(NASA-TN-D-4165) CFSTI: HC$3.00/MF$0.65 CSCL 20M

Consistent thermodynamic properties of potassium from the melting point (336.35°K) to 2100°K were computed for both the ideal and the real species and are presented in tabular form. The properties computed for the real monomeric vapor on the saturation line are as follows: pressure, volume, heat capacity, enthalpy of vaporization and enthalpy, entropy of vaporization and entropy, fugacity-pressure ratio, virial coefficients (second, third, and fourth), compressibility factor, density, partial derivative of volume with respect to temperature at constant pressure, and partial derivative of volume with respect to pressure at constant temperature. The properties computed for the ideal species (condensed phases, monomeric gas, and dimeric gas) are heat capacity, enthalpy, entropy, and free energy. The real-gas properties were computed from a virial equation of state. The equation used existing second virial coefficients based on the Rydberg potential. Third and fourth virial coefficients exhibiting limited aspects of hard-sphere behavior were adjusted to experimental pressure-volume-temperature(PVT) data. Author

N67-35791# Bettis Atomic Power Lab., Pittsburgh, Pa.

THERMAL CONDUCTIVITY OF BULK OXIDE FUELS

J. Belle, R. M. Berman, W. F. Bourgeois, I. Cohen, and R. C. Daniel Apr. 1967 99 p refs Revised
(Contract AT(11-1)-GEN-14)
(WAPD-TM-586, Rev.) CFSTI: CH$3.00/MF$0.65

Data are reported on the thermal conductivity of the oxide fuels ThO_2, ThO_2–UO_2, ZrO_2–UO_2, ZrO_2–UO_2–CaO, and UO_2 prepared by various ceramic fabrication techniques. The thermal conductivity of low-density bodies was found to be highly dependent on the fabrication technique and, therefore, resulting pore structure; a computer simulation of porous bodies was successful in reproducing the measured sensitivity to pore shape. Factors effecting the thermal conductivity of irradiated fuel bodies are reviewed, and a relation between conductivity, porosity, depletion level, and temperature is proposed for various oxide fuels. Author (NSA)

N67-35878# Atomic Energy Establishment, Winfrith (England). Reactor Development Div.

A VISUAL STUDY OF FORCED CONVECTION BOILING. PART 2: FLOW PATTERNS AND BURNOUT FOR A ROUND TEST SECTION

G. J. Kirby, R. Staniforth, and J. H. Kinneir Mar. 1967 30 p refs
(AEEW-R-506) CFSTI: HC$3.00/MF$0.65

Studies of boiling water at 25 lb/in.^{2} abs indicate the same flow patterns as earlier tests. Bubbles formed on the heater remained close to the heated surface and coalesced into large bubbles which eventually spanned the flow channel. The flow pattern at burnout was dependent on the degree of subcooling; at high subcooling only nucleate bubbles were present, whereas at low subcooling the channel was full of large vapor bubbles. In the former case the burnout heat flux was dependent only on local conditions. Author (NSA)

N67-35897# Martin Co., Orlando, Fla.

COMPILATION OF ABSTRACTS—3rd AFOSR COMBINED CONTRACTORS MEETING ON COMBUSTION DYNAMICS RESEARCH

[1967] 66 p ref Meeting held in Cocoa Beach, Fla., 27–30 Jun. 1967
(Contract AF 49(638)-1566)
(AFOSR-67-0391; AD-654669)

Abstracts are presented under one of three major subject headings: advanced air breathing combustion, liquid propellant rocket combustion, or solid propellant rocket combustion. Author (TAB)

N67-35912 Nuklearni Institut Jozef Stefan, Ljubljana (Yugoslavia).

STEADY HEAT FLOW OUT OF SOLIDS WITH TEMPERATURE DEPENDENT CONDUCTIVITY

J. Vdovic and A. Alujevic Feb. 1967 8 p refs Submitted for publication
(NIJS-R-497)

In estimating the grinding required for ceramic tablets to compensate disproportions in dilatations in the center and at the boundaries of the tablets in the axial direction, the detailed temperature distribution is needed with temperature dependent thermoconductivity $\lambda(\theta)$ taken into account. The temperature dependent resistivity $1/\lambda$ is linear. In addition, the internal heat generation in the fuel is constant, although it slightly increases from the center to the boundary of the tablet. An arbitrary number of dimensions (i.e., the plane and/or space problem) is considered, if the interval heat generation is arbitrarily distributed and with an arbitrary dependence of heat conductivity. The general solution is given in a graphic form which yields the qualitative estimation of various influences. The possibility of an analytical solution is also considered. Author

N67-35925# Polytechnic Inst. of Brooklyn, N. Y. Dept. of Aerospace Engineering and Applied Mechanics.

RESTRICTED VARIATIONAL PRINCIPLE AND THE SOLUTION OF RADIATIVE TRANSFER EQUATION

Prem K. Khosla May 1967 8 p refs
(Contract Nonr-839(34))
(PIBAL-1020; AD-654891)

The use of restricted variational principles in the study of irreversible thermodynamics and kinetic theory is quite well-known.

Especially in the latter case, the use of variational techniques in connection with Mott-Smiths method (using bimodal distribution) removes the arbitrariness of finding the additional moments. The moment equations containing the effect of collisions are determined by the variational principle. In the present note we shall use this restricted variational principle for solving the radiative transfer equation for a grey gas. Author (TAB)

N67-35931# Societe pour l'Etude et la Realisation d'Engins Balistiques, Courbevoie (France).
THERMAL STUDY OF SATELLITE [ETUDE THERMIQUE DU SATELLITE]
Dec. 1964 23 p In FRENCH Prepared for ELDO
(DTA-50-4644, Append. IV) CFSTI: HC $3.00/MF $0.65

Passive thermal control of ELDO A-S satellite is discussed. Two versions are considered: (a) where solar cells are arranged in plane perpendicular to axis of satellite and (b) where cells are arranged in four orthogonal planes across axis of satellite. The latter offers finer control than former. ESRO

N67-36022# Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorbauelemente.
THERMODYNAMIC PROCESSES IN FUEL ELEMENTS WITH DETERMINATION OF THE TEMPERATURE DISTRIBUTION [UEBER THERMODYNAMISCHE VORGAENGE IN BRENNELEMENTEN MIT ERMITTLUNG DER TEMPERATURVERTEILUNG]
H. Sundermann Feb. 1967 10 p refs In GERMAN Sponsored by EURATOM
(KFK-477)

The possible effect of various thermodynamic processes on fuel elements was considered. The effect of fission gas distribution with respect to the equilibrium standardization with consideration of diffusion processes was discussed. The surface voltage and the heat induction in the fuel element at varying local temperatures was also considered. The general effect of the temperature on the fuel element cladding was indicated. Author (NSA)

N67-36072# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.
EXTERNAL BURNING IN SUPERSONIC STREAMS
F. S. Billig May 1967 132 p refs
(Contract NOw-62-0604-c)
(TG-912; AD-655460)

Theoretical and experimental studies of heat addition to external supersonic streams are reviewed, following a brief explanation of the basic fluid mechanical model and possible applications of external burning. Previously developed methods and a new, simplified method for obtaining linearized heat addition solutions are presented. The numerous analyses of combustion via a stationary detonation wave are categorized into four models for planar heat addition, and the equations are developed for the most interesting case of the oblique Chapman-Jouget detonation. The governing equations for a constant-pressure analysis are developed, and performance estimates are given for heat addition adjacent to both double-wedge and flat-plate surfaces. Experimental results of all available external burning tests are discussed, including tests of two-dimensional and axisymmetric bodies. Data are compiled, summarized, and analyzed. The maximum expected pressure coefficient will be near that associated with a separated boundary layer. To obtain the theoretical maximum specific impulse, highly reactive fuels with a combustion length of a few feet will be required. Author (TAB)

N67-36080*# General Electric Co., Philadelphia, Pa. Missile and Space Div.
DEVELOPMENT OF PHASE-CHANGE COATINGS FOR USE AS VARIABLE THERMAL CONTROL SURFACES Final Report
R. N. Griffin and B. Linder Sep. 1967 59 p refs
(Contract NAS1-5330)
(NASA-CR-66394) CFSTI: HC $3.00/MF $0.65 CSCL 20M

A phase-change coating system consisting of dioctadecyl phosphite in poly(vinyl butyral) has been developed which changes in α_s/ϵ ratio by about a factor of two between 25°C and 50°C. The reversible change in α_s/ϵ is stable through at least 10^3 thermal cycles in vacuum and is nearly unaffected by exposure in vacuum to 100°C for ten minutes, 1000 equivalent sun-hours of ultraviolet, and 100 Mrad of X-ray. The coating can be applied either by brushing or spraying. When the coating is heated to 50°C, it changes from its high absorptance to its low absorptance form within seconds. Recovery of the high absorptance on cooling requires a period of minutes. In some systems, there is no unique "phase-change" temperature, but rather a constant change of absorptance with temperature over a range of at least 20°C. There is, however, a temperature at which the coating undergoes a rapid change in absorptance. In the test coatings, this temperature is at or just below the melting point of the pigment. Evaporation of the pigment in vacuum was shown to be a major concern for most phase-change coatings, leading to permanent changes in optical properties and possible contamination of neighboring surfaces. An effective method of preventing such evaporation was developed, making rates of evaporation unmeasurably low. Author

N67-36099# Tokyo Univ. (Japan). Inst. of Space and Aeronautical Science.
AERODYNAMIC STUDY OF STAGNATION ABLATION
Keiichi Karashima and Hirotoshi Kubota Jun. 1967 35 p refs
(ISAS-413, Vol. 32, No. 6) CFSTI: HC $3.00/MF $0.65

Presented is a theoretical approach to stagnation ablation during hypersonic reentry of blunt-nosed bodies of revolution. Equations are derived for a nonreacting laminar boundary layer flow of a binary gas mixture, using the kinetic theory of gases to account for transport properties. It is shown that all physical properties of the ablating field can be determined under the given boundary conditions by matching an aerodynamic solution with a static one obtained from chemical kinetics. Error in estimating the Chapman–Rubesin and the Schmidt numbers across the boundary layer is most sensitive to the aerodynamic solution, indicating that viscosity and diffusivity of the gas mixture greatly affect flow characteristics of the ablating field. Numerical calculations for a Teflon ablator show that the ablation rate increases with increasing stagnation temperature in free stream; wall temperature does not rise much, indicating that Teflon is a good ablating aerodynamic heat shield for comparatively low enthalpy flow. To confirm validity of this approach, theoretical results are compared with experimental data for Teflon. Agreement between theory and experiment is fairly good in the stagnation temperature range from 800° to 1200°C. K.W.

N67-36106 Deutsche Versuchsanstalt für Luft- und Raumfahrt, Munich (West Germany). Institute fuer Raketentreibstoffe.
CHEMICALLY HEATED HYDROGEN THROUGH TRIBRIDE COMBUSTION [CHEMISCHE WASSERSTOFFAUFHEIZUNG DURCH TRIBRIDE VERBRENNUNG]
1967 13 p Presented at DGRR Symp. Chem. Raketentriebwerke, Munich, 21 Mar. 1967
CFSTI: HC $3.00/MF $0.65

Metal combustion is examined as a chemical means for increasing the combustion temperature and propulsion efficiency of hydrogen. Problems connected with the combustion of pure metals in high-energy propellant systems of the oxidizer/metal/hydrogen type are reviewed. Unconventional solutions such as powder combustion and cryogenic solid propellants are considered in addition to tribrid combustion in the presence of binders with specific properties. The use of lithium as a high-energy binder for beryllium is discussed, and the performance of other tribrid systems is briefly compared with pure metal combustion. Transl. by K.W.

N67-36135# California Univ., Santa Barbara. Physics Dept.
PHOTOMETRIC MEASUREMENTS ON THE DEVIATIONS FROM THE EQUILIBRIUM STATE IN BURNT FLAME GASES
H. P. Broida 1 Jul. 1967 16 p refs
(Contract Nonr-4222(01); ARPA Order 125)
(TR-22; AD-655143)

Photometric investigations are reported in laminar, premixed shielded flames above the reaction zone, burning at atmospheric pressure. In these CO/N2/O2 - C2H2/N2/O2 - and H2/O2/N2 - flames metal vapor was introduced. Flame temperatures ranged from 2000 to 2500K, rise-velocities from 5 to 15 m/sec. The question is discussed as to what extent thermodynamic equilibrium does exist in (certain parts of) the flame. The meaning of (local) flame temperature and its relation to calculated adiabatic temperature and excitation temperature is considered. Complications due to suprathermal chemiluminescence and radiative nonequilibrium effects are discussed. Recombination of excess radicals causes an initial rise in temperature with height and leads to suprathermal chemiluminescence of metal lines and to continuous background radiation. Radiative non-equilibrium causes underpopulation of excited metal states and can be studied by excitation temperature measurements. From departures from metal-ionization equilibrium conclusions are drawn about the ionization mechanism, effective cross-sections and relaxation times. Chemi-ionization is also dealt with. The negligible of influence of excess O-radicals in CO flames on the dissociative equilibrium makes possible to exclude particular dissociation reactions. From the measured equilibrium population of the visible alkaline-earth bands molecular excitation energies were derived and conclusions about the kind of emitters were drawn. Author (TAB)

N67-36137# Sandia Corp., Albuquerque, N. Mex.
ANALYSIS OF HEAT TRANSFER AND BOUNDARY LAYER TRANSITION ON A BLUNT BODY AT HYPERSONIC SPEEDS
R. C. Maydew May 1967 39 p refs
(Contract AT(29-1)-789)
(SC-RR-67-142) CFSTI: HC $3.00/MF $0.65

Local pressures and heat transfer rates were measured on a flat-nose, cone-cylinder-flare model in a hypersonic shock tunnel at Mach numbers of 6.6 to 8.0 and Reynolds numbers of 0.8 to 35×10^6/ft. The cone-cylinder heat transfer data correlate with the theories of Van Driest for the laminar boundary layer and Spalding and Chi for the turbulent boundary layer. The local Reynolds number at the beginning of transition, based on wetted length from the stagnation point, was approximately 0.2×10^6 on both the conical and cylindrical sections. Author (NSA)

N67-36155 National Aerospace Lab., Tokyo (Japan).
MEASUREMENTS OF HEAT-TRANSFER TO TEFLON IN DISSOCIATED HYPERSONIC FLOW
Shigeaki Nomura 1967 15 p refs In JAPANESE; ENGLISH summary
(NAL-TR-133)

Heat-transfer rates to Teflon and to polished copper are measured in low density hypersonic flow of partially dissociated nitrogen at Mach number 5, with flow enthalpies of 1,400 to 2,500 cal/g and impact pressure of 15 mmHg. The heat-transfer rate to Teflon is obtained from the transient temperature rise at the rear surface of the Teflon coated stainless steel disk before ablation starts. The thickness of the Teflon film is 0.1 mm. The ratio of heat-transfer rates to both Teflon and copper surfaces is reduced from 1.0 to 0.6 as stagnation enthalpy is increased from 1,400 to 2,500 cal/g. Comparing these experimental results with the theoretical value introduced by Goulard, it is shown that the effect of catalytic recombination upon the heat-transfer to the Teflon surface is very small compared with that to the copper surface. Author

N67-36168# RAND Corp., Santa Monica, Calif.
ENERGY TRANSFER IN PARTICLE-SURFACE INTERACTIONS IN HYPERVELOCITY FLIGHT: COMMENTARY AND BIBLIOGRAPHY
F. C. Hurlbut Jul. 1967 77 p refs
(Contract F44620-67-C-0045; Proj. RAND)
(RM-4885-PR; AD-655066)

The memorandum reviews thermal-energy transfer in particle-surface interactions and presents an extensive, partially annotated bibliography of literature relevant to this field. The subject area is limited to nonreactive energy transfer between neutral gas molecules and surfaces at energy levels of interest to gas dynamicists and hence is extended, in these terms, from the energies associated with gases at low temperatures to those associated with the velocities of satellites. A summary of values of the thermal accommodation coefficients obtained over the years is given, and the experimental methods used and the current interpretation of the results are reviewed. A discussion and evaluation of current and past theoretical work in this area is also included. Author (TAB)

N67-36228*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
INHOMOGENEOUS RADIANT HEAT TRANSFER FROM SATURN ROCKET EXHAUST PLUMES
Robert M. Huffaker 30 Jun. 1967 53 p refs
(NASA-TM-X-53630) CSCL 20M

A radiant heat transfer computer program has been developed to calculate radiation from inhomogeneous gases prevalent in rocket exhaust plumes from clustered engines. The infrared spectral absorption characteristics of the radiating species considered in this computer program—water vapor, carbon dioxide, carbon monoxide and carbon particles—have been determined. Band model parameters have been used to represent the infrared spectral absorption coefficients over 25 cm^{-1} increments. A modified approximation, used in the inhomogeneous heat transfer calculation, has been shown to give satisfactory results over the temperature and pressure range of interest in Saturn exhaust plumes. Results are shown for the Saturn-type engines for specific flow field assumptions. Some comparison with experimental spectroscopic data are presented. The effects of wavelength increment, field of view, and distance increment along the line of sight on the heat transfer, as well as the computer techniques for minimum computer time in calculating radiation from a three-dimensional flow field, are discussed. Author

N67-36395*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
SUMMARY OF HEAT FLUX AND PRESSURE INSTRUMENTATION USED IN RECENT SATURN ROCKET EXHAUST TESTS
William C. Rochelle 24 May 1967 35 p refs
(NASA-TM-X-53613) CSCL 20M

Various types of instrumentation used in obtaining heat flux and pressure measurements in the exhausts of a number of Saturn rockets fired in the last two years are discussed. Analysis of experimental data obtained by various measuring techniques is an important factor is correlating predictions of pressure and heating from exhausts of liquid propellant main stage engines and solid propellant ullage and retro-motors used for stage separation purposes. The testing techniques at various facilities including type and location of instrumentation used and principal results obtained from the instrumentation are described. Author

N67-36409* Louisiana State Univ., Baton Rouge. Reacting Fluids Lab.
NON-EQUILIBRIUM FLOW AND THE KINETICS OF CHEMICAL REACTIONS IN THE CHAR ZONE
Ralph W. Pike, Gary C. April, and Eduardo G. del Valle 15 Jul. 1967 100 p refs
(Grant NGR-19-001-016)
(NASA-CR-66455; NASA-RFL-7) CSCL 20M

In the temperature range from 500° to 2500°F nonequilibrium flow analysis predicted a small change in degradation product composition as the gases flow through the char zone. Essentially all the reaction occurred in the temperature range from 2000° to 2500°F. Comparing nonequilibrium flow with the two limiting cases, the energy absorbed in the char zone for frozen flow was on half of that of nonequilibrium flow, and equilibrium flow was two and one half times that of nonequilibrium flow. Results were obtained by simulating the char zone during ablation in the temperature range from 900° to 1650°F. The data showed that the flow was frozen, and this was accurately predicted by the nonequilibrium flow analysis. The limiting case of equilibrium flow incorrectly predicted significant changes in degraded product composition in this temperature range. Details are given concerning the criteria used for selecting the chemical reactions that were important in the char zone, the generalized reaction kinetics analysis, the computer solutions of the equations, and the experimental system. Author

N67-36419*# Stanford Univ., Calif. Inst. for Plasma Research
SHOCK TUBE STUDY OF THE THERMAL CONDUCTIVITY OF ARGON
Jackie O. Bunting and R. S. Devoto Jul. 1967 106 p refs
(Grant NGR-05-020-091)
(NASA-CR-88360; SUDAAR-313; SU-IPR-176) CFSTI: HC $3.00/MF $0.65 CSCL 20M

The end-wall thermal boundary layer behind a reflected shock has been analyzed to determine the thermal conductivity of argon over the temperature range from 3150° to 9225°K. Pressures behind the reflected shock, assumed constant through the thermal layer, were chosen sufficiently high to suppress non-equilibrium and side-wall effects. Temperature profiles, computed from interferometric measurements of density, were compared with a numerical solution of the full nonlinear thermal boundary layer equations assuming a temperature dependence for thermal conductivity of the form $K\alpha T^{\nu}$. Typically, 10 to 12 points were obtained in a thermal layer which was approximately 1.5 mm thick, with the nearest points approaching 0.2 mm from the wall. Refraction effects and related optical distortion precluded measuring closer to the surface. Values for the exponent ν in the power law were obtained by minimizing the root-mean-square deviation between the theoretical and experimental profiles. From 18 temperature profiles the average value obtained for ν was $0.668 \pm .02$. This value was compared with existing theoretical predictions and with other measurements. The results offer encouragement for similar studies at even higher temperatures where free electrons will affect the thermal transport. Author

N67-36432* Farnham (Frank C.) Co., Philadelphia, Pa.
THEORY OF DIFFUSION IN SOLUTIONS NEAR THE CRITICAL POINT [DO TEORIYI DYFUZIYI U ROZCHYNAKH POBLYZU KRYTYCHNOHO STANU]
M. P. Kovalenko Washington, NASA, Jul. 1967 10 p refs Transl. into ENGLISH from Ukr. Fiz. Zh. (Kiev), v. 12, no. 1, Jan. 1967 p 111–116
(Contract NASw-1497)
(NASA-TT-F-11102) CSCL 20M

Study of diffusion processes in solutions which are in states close to the critical. It is shown that in the neighborhood of critical points, degeneration of Fick's equations leads to a linear dependence of the diffusion flows and to an increase in correlation effects. On the basis of the thermodynamics of irreversible processes, corrected diffusion equations are obtained, which take into account nonlinear and correlation effects. It is shown that the solution of equations with correlation terms for the problem of diffusion into a capillary in three-component solutions leads to the conclusion that the process of diffusion occurs in two stages, each of which is distinguished by its own rate. It is also found that resorption of concentration gradients may occur nonmonotonically, in contrast to ordinary diffusion. Author

N67-36443* Scientific Translation Service, La Canada, Calif.
CALCULATION OF REDUCED THERMODYNAMIC POTENTIALS FOR SOME CARBIDES AND NITRIDES [RASCHET PRIVEDENNYKH TERMODINAMICHESKIKH POTENTSIALOV NEKOTORYKH KARBIDOV I NITRIDOV]
R. F. Voytovich Washington, NASA, Jul. 1967 5 p refs Transl. into ENGLISH from Poroshkovaya Met., Akad. Nauk Ukr. SSR (Kiev), v. 7, no. 2, 1967 p 40–43
(Contract NASw-1496)
(NASA-TT-F-11117) CSCL 20M

Reduced thermodynamic potentials of some carbides and nitrides at temperatures of 298°, 500°, 1000°, 1500° and 2000°K are calculated. Author

N67-36457* Little (Arthur D.), Inc., Cambridge, Mass.
REFRIGERATED TRANSMISSION LINE STUDY. VOLUME II: TECHNIQUES AND REFRIGERATION SYSTEMS FOR COOOLING COMPONENTS OF MICROWAVE RECEIVING SYSTEMS TO 80°K–100°K
Mar. 1967 166 p Prepared for JPL Suppl. to Vol. I
(Contracts NAS7-100; JPL-951638)
(NASA-CR-88120; C-68600, Vol. II) CSCL 13A

Techniques for individually cooling various components of the Deep Space Instrumentation Facility (DSIF) Tracking Cone Receiving Systems and refrigeration systems were investigated. Conceptual designs for cooling components and of a suitable refrigeration system were developed. Thermal insulation, heat loads, liquid nitrogen cooling systems, and ambient temperature cooling systems are discussed. Results of work efforts are presented, and conclusions are stated. L.S.

N67-36489*# Lockheed Missiles and Space Co., Palo Alto, Calif. Aerospace Sciences Lab.
DEVELOPMENT OF THERMAL TESTING TECHNIQUES AT HIGH SOLAR INTENSITIES Final Report, 13 Aug. 1965–13 May 1967
R. E. Rolling and K. N. Marshall Jun. 1967 87 p refs
(Contract NAS2-3164)
(NASA-CR-73098) CFSTI: HC $3.00/MF $0.65 CSCL 20M

Several solar energy simulation techniques were investigated in terms of their potential use in performance testing of vehicles which function at near-solar distances. These include carbon arc, xenon arc, filtered xenon arc, and tungsten filament lamps. Both analytical and experimental results were obtained on a half-scale model of an advanced Pioneer-type spacecraft to establish the sensitivity of the prototype thermal design to the various kinds of simulation. The model design utilized an external thermal control surface and was tested using a carbon arc solar simulator at 1 solar constant and using tungsten lamp simulation at 1, 5, and 9 solar constants. A thermal analyzer program was used to predict test temperatures of the model and to forecast its actual space performance. The results indicated that testing of the spacecraft with high quality carbon arc or filtered xenon-arc simulators would result in a satisfactory indication of flight performance, although actual flight temperature would not be duplicated. Similar testing with high-temperature tungsten filament lamps will require filtering of all energy emitted at wavelengths beyond 4.5 μ due to the spectrally selective surfaces used on the exterior of the vehicle. Author

N67-36502* Holman (John F.) and Co., Inc., Washington, D. C.
ESTABLISHMENT OF THERMODYNAMIC EQUILIBRIUM IN DISCHARGES [K VOPROSU OB USTANOVLENII TERMODINAMICHESKOGO RAVNOVESIYA V RAZRYADAKH]
N. A. Prilezhayeva and V. V. Kokhanenko Washington, NASA, Mar. 1967 6 p refs Transl. into ENGLISH from Nekotorye Vopr. Emission. i Molekul. Spektroskopii (Krasnoyarsk, USSR), 1960 p 3–8
(Contract NASw-1495)
(NASA-TT-F-10822) CSCL 20M

To test the presence of thermodynamic equilibrium in discharges, detonations were made from spectral data of the rotational temperature (T_r) and vibrational temperature (T_v) of CN molecules and the electron temperature (T_e) (from lines of atoms of Cu, Ba, and Zn) for an arc discharge in air between C electrodes. With increase in pressure T_e and T_r approach each other, and remain nearly coincident at $\geq$200 mm, while T_v remains lower that T_e and T_r throughout this entire interval. However, this does not contradict thermodynamic equilibrium, because CN molecules are formed in the discharge and within the duration of the excited state (10^{-9} sec), may not be able to accomplish an energy exchange between oscillatory degrees of freedom. Stationary N_2 and CO molecules in the discharge cannot be used for detonation of T_v since they do not radiate in an arc discharge. Similar results were obtained for a glow discharge, but the approximation of T_e to T_r occurs at 90 mm. Conditions leading to destruction of thermodynamic equilibrium in discharges are discussed. Author

N67-36503# Aerojet-General Nucleonics, San Ramon, Calif. Nuclear Products and Services Group.

ALKALI METALS EVALUATION PROGRAM. THERMODYNAMIC AND TRANSPORT PROPERTIES OF POTASSIUM: PVT PROPERTIES

P. Y. Achener, A. R. Miller, and D. L. Fisher Apr. 1967 67 p refs

(Contract AT(04-3)-368)

(AGN-8194, Vol. 2) CFSTI: HC $3.00/MF $0.65

The pressure—volume—temperature properties of super-heated K vapor at 1149.8 to 1478.8°K at pressures from 2.412 to 14.14 atm were determined. The experimental method involved the use of a constant-volume capsule fitted with a null-type diaphragm for measurement of pressure. The experimental data were used to develop a virial equation of state explicit in pressure, from which the desired properties of enthalpy, entropy, specific heat, and compressibility were calculated. Author (NSA)

N67-36512# Iowa State Univ. of Science and Technology, Ames.

DYNAMIC MASS TRANSFER MEASUREMENTS IN FALLING DROPS

William Allen Scholle (M.S. Thesis) Nov. 1966 79 p refs

(Contract W-7405-ENG-82)

(IS-T-130) CFSTI: HC $3.00/MF $0.65

Mass transfer measurements were made from falling drops by relating their velocity of fall to their density. Formation data were obtained by comparing the fall velocities of drops that formed on a tip to drops having no mass transfer during formation. For the system of carbon tetrachloride-benzene, aqueous sodium iodide solution, and iodine, the rate of fall was strongly dependent on the iodine concentration in the drop. During the fall period there was a change in the mass transfer mechanism corresponding to a transition from circulation to non-circulation within the drop. During formation the drop was well mixed and most of the resistance to mass transfer was in the continuous phase. A rapid build up of solute on the outside of the drop caused an additional resistance while the high solution density caused a flow of solute along the surface of the drop tending to decrease the resistance. Author (NSA)

N67-36596# General Electric Co., Schenectady, N. Y. Research and Development Center.

PREDICTION OF THE VOID FRACTION IN SUBCOOLED BOILING, ANNULAR FLOW, AND IDEAL BUBBLY FLOW: ASSIGNMENT REPORT USAEC–EURATOM PERSONNEL EXCHANGE, MAY–DECEMBER, 1966

F. W. Staub Jan. 1967 116 p refs

(Contract AT(04-3)-189)

(GEAP-5414; EURAEC-1852) CFSTI: HC $3.00/MF $0.65

The derivation of a set of relations which permit the prediction of the initial point of net vapor generation is presented and satisfactory agreement with data is shown over a large range of fluid velocity, reduced pressure and for two different fluids. A semi-empirical formulation for the light phase drift velocity in annular flow is given and compared to the data. The method for the calculation of the void fraction in ideal bubbly flow is reviewed, extended and compared to data in both ideal and turbulent bubbly flow conditions. (NSA)

34 GENERAL

Includes reports of a broad nature related to industrial applications and technology, and to basic research; defense aspects; law and related legal matters; and legislative hearings and documents.

N67-36530# Mellon Inst., Pittsburgh, Pa.

MELLON INSTITUTE RESEARCH Annual Report, Period Ending 28 Feb. 1967

28 Feb. 1967 49 p refs

(AR-54) Available from Mellon Inst., Pittsburgh, Pa.

Work progress in the areas of: biochemistry and molecular biology; environment and public health; structure and properties of organic materials; polymer systems; continuum physics and viscoelasticity; radiation induced reactions; nuclear magnetic resonance spectroscopy; molecular physics and spectroscopy; structure and properties of inorganic materials; chemical physics; metal physics and metallurgy; and instrumentation services, is reported. Professional personnel affiliated with the Mellon Institute, member's lectures, and publications of the members, are listed. L.S.

N67-36596*# National Aeronautics and Space Administration, Washington, D. C.

INDEX TO NASA TECH BRIEFS, JANUARY–JUNE 1967

Aug. 1967 47 p

(NASA-SP-5021(05)) CFSTI: HC $3.00/MF $0.65 CSCL 05B

Abstracts and a subject index are presented for the technological innovations in the categories of electricity and electronics, physical and life sciences, materials, mechanics, and computer programs. Indices of the tech brief/originator number and the originator/tech brief number are included. N.E.N.

N67-35839# Brookhaven National Lab., Upton, N. Y.

BUBBLE CHAMBERS BIBLIOGRAPHY, SUPPLEMENT I

Marjorie Comstock 1 May 1967 33 p refs

(BNL-8083, Suppl. I) CFSTI: HC $3.00/MF $0.65

One hundred and eighty-eight references are presented on bubble chambers components and applications to supplement a previous bibliography dated May 28, 1964. The references are arranged in chronological order and an author index is included. NSA

N67-35900 Joint Publications Research Service, Washington, D. C.

ORGANIZATION OF INTERDISCIPLINE CYBERNETIC STUDIES IN THE USSR

S. Mikluinskiy 2 Aug. 1967 7 p Transl. into ENGLISH from Izv. (Moscow), 20 Jun. 1967 5 p

(JPRS-42057; TT-67-32687) CFSTI: HC $3.00

Problems related to the complexity of scientific and technological progress, the dependence of this progress on economic and social factors, and the rapid changes which have occurred in the nature of scientific activity and the structure of science are discussed. A new branch of knowledge is described which treats science as a particular form and system of activity. It is called the science of science or "scientifics", and studies the general patterns of the functioning and development of science and technology. The goal of "scientifics" is to work out the theoretical bases of the organization, planning, and control of science; and systems of measures to provide the optimum rates of scientific research and to raise research efficiency. A recommendation is made that a special center and a scientific council be created to systematically study the development patterns of science. R.N.A.

N67-35972*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
SPACE PROGRAMS SUMMARY NO. 37-32, VOLUME IV FOR THE PERIOD FEBRUARY 1, 1965 TO MARCH 31, 1965. SUPPORTING RESEARCH AND ADVANCED DEVELOPMENT
30 Apr. 1965 117 p refs
(Contract NAS7-100)
(NASA-CR-88108; JPL-SPS-37-32, Vol. IV) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Systems analyses and computer applications are discussed in relation to space exploration programs, and microbiological techniques for spacecraft sterilization are assessed. Guidance and control research centered on analysis and integration, magnetics, semiconductors, and spacecraft secondary power sources. Brief reports are given on results pertaining to the structure and magnetic properties of glassy carbon, high impact technology, applied mechanics, wind tunnel and hypervelocity test facilities, and instrumentation. In the area of propulsion, various aspects of solid propellant engineering, polymer research, advanced concepts, and liquid propulsion systems are examined. Slow-scan vidicon sterilization tests are reviewed, and several space instruments and instrument systems are discussed. Summary data are provided on soil studies, fluorometric analyses of urea, fluid physics and physics developments, and an infrared detector analysis facility. Telecommunications progress is reported on components, information processing, planetary radar, and communication and tracking. M.G.J.

N67-35980 Congress. House. Committee on Science and Astronautics.
TECHNOLOGY ASSESSMENT
Emilio Q. Daddario Washington, GPO, 1967 20 p Hearings before Comm. on Sci. and Astronautics, 90th Congr., 1st Sess.

Technology assessment is defined as a form of policy research which provides a balanced appraisal to the policymaker, and is designed to uncover and to distinguish between desirable, undesirable, and uncertain consequences. Historical illustrations of unpredicted or unassessed consequences are given. Bills before Congress to establish committees on science and technology, and university programs on the impacts of technology are presented as examples of the growing awareness of the need for assessment. The rapid rate of present-day technological change, the world wide population density, and the available forces for change are mentioned as causes for the urgency of current assessment. Steps to be undertaken to determine the scope of technology assessment are outlined. These include seminars and hearings to refine present ideas, and discussions with the National Academies of Science and Engineering on the possibility of obtaining a substantial and concerted effort in developing the concept. N.E.N.

N67-35995# National Research Council of Canada, Ottawa (Ontario).
DIVISION OF MECHANICAL ENGINEERING AND THE NATIONAL AERONAUTICAL ESTABLISHMENT Quarterly Bulletin, 1 Jan.–31 Mar. 1967
31 Mar. 1967 120 p refs
(DME/NAE-1967(1)) CFSTI: HC $3.00/MF $0.65

CONTENTS:

1. THE DESIGN OF OPTIMAL EXTREMAL CONTROLLERS C. M. Woodside p 1–53 refs (See N67-35996 21-10)
2. AERIAL FOREST FIRE CONTROL D. G. Gould p 55–71 refs (See N67-35997 21-34)
3. LUBRICATING GREASES FOR AERONAUTICAL/AEROSPACE APPLICATIONS L. D. New p 73–78 refs (See N67-35998 21-15)

N67-35997# National Research Council of Canada, Ottawa (Ontario). Flight Research Lab.
AERIAL FOREST FIRE CONTROL
D. G. Gould *In its* Div. of Mech. Eng. and the Natl. Aero. Estab. 31 Mar. 1967 p 55–71 refs (See N67-35995 21-34)

The utilization of aircraft to control forest fires is briefly reviewed. In the area of fire detection, a number of operational studies have indicated that aircraft utilization is at least as effective and less costly than fixed-point or combined fixed-point aerial detection systems. For detecting lightning fires following storms, aerial infrared detection systems are being used more extensively. The aerial water bombing method is as effective in control and suppression of fires and is used in varying degrees by all fire suppression agencies. The versatility of the helicopter is cited in its function of transporting men and equipment, as well as for general surveillance activities. R.Li.

N67-36101*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
SPACE PROGRAMS SUMMARY NO. 37-26, VOLUME IV FOR THE PERIOD FEBRUARY 1, 1964 TO MARCH 31, 1964. SUPPORTING RESEARCH AND ADVANCED DEVELOPMENT
30 Apr. 1964 280 p refs
(Contract NAS7-100)
(NASA-CR-88109; JPL-SPS-37-26; Vol. IV) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Summaries are presented of work covering the following fields or subjects: (1) trajectory optimization and orbital calculations; (2) spacecraft power sources and guidance and control; (3) research in ceramics, graphite, and electronic packaging; (4) wind tunnel and hypervelocity research in gas dynamics and aerodynamic characteristics; (5) solid propellant engineering, advanced propulsion research, and polymer chemistry; (6) space instruments systems, planetary probes, and space-related chemistry research; (7) physics studies in boundary layer stability, particle interaction, propellant efficiency, plasma behavior, and dayglow measurement; and (8) research in components and systems for space communications, coding and filter theory, and radar astronomy. K.W.

N67-36147# Sandia Corp., Albuquerque, N. Mex.
INDEX OF PROCEEDINGS OF REMOTE SYSTEMS TECHNOLOGY DIVISION OF AMERICAN NUCLEAR SOCIETY, VOLUMES 1–14
R. M. Jefferson May 1967 74 p
(Contract AT(29-1)-789)
(SC-R-67-1056) CFSTI: HC $3.00/MF $0.65

The volume is made up of author, corporate author, and subject (keyword) indexes. NSA

N67-36406* New York Univ., N. Y. Lab. for Electroscience Research.
INFORMATION PROCESSING OF DATA DESCRIBING ARBITRARY SOLIDS Semiannual Status Report, 1 Dec. 1966–1 Jun. 1967
Herbert Freeman Jul. 1967 16 p refs
(Grant NGR-33-016-038)
(NASA-CR-88368) CSCL 05B

The research carried out during the past six-month period consisted of three specific investigations. The first of these was concerned with the topological and geometric properties of terrain contour maps, and with the solution of the so-called contour-map search problem. The second investigation has as its objective the development of an efficient algorithm for the solution of the "hidden-line" problem for polyhedra of arbitrary complexity. The third investigation was concerned with the reconstruction of an arbitrary polyhedron from two or more of its projections. All three investigations are briefly described. Author

N67-38425# Congress. House. Committee on Science and Astronautics.
NASA AUTHORIZATION FOR FISICAL YEAR 1968, INDEX FOR PARTS 1, 2, 3, AND 4
Washington, GPO, 1967 160 p Hearings before Comm. on Sci. and Aeron., 90th Congr., 1st. Sess.

An index of personal names and a subject index are presented for each of parts 1, 2, 3, and 4 of the hearings before the House Committee on Science and Astronautics of the first session of the Ninetieth Congress. M.W.R.

N67-38454 National Aeronautics and Space Inst., Bandung (Indonesia).
NATIONAL REPORT OF INDONESIA, JULY 1, 1966–JULY 1, 1967
1 Jul. 1967 1 p

A report on the status of the space effort, and of the condition of the Space Center in Indonesia is presented. Work is proceeding with ionospheric data previously obtained with rocket probes. L.S.

N67-38582*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
AUTOMATED LITERATURE PROCESSING HANDLING AND ANALYSIS SYSTEM—FIRST GENERATION
Redstone Arsenal, Ala., Redstone Sci. Inform. Center, 23 Jun. 1967 513 p Prepared by Hayes International Corp. Joint report with Army Missile Command
(Contract DAAH03-67-C-0019)
(NASA-TM-X-60246; RSIC-549; Rept.-17) CFSTI: HC $3.00/MF $0.65 CSCL 05B

A summary is given of the development and the characteristics of the first generation of the Automated Literature Processing, Handling, and Analysis (ALPHA-1) system. Descriptions of the computer technology of ALPHA-1 and of the use of this automated library technique are both presented. Each of the subsystems and modules now in operation are covered to provide a background for adapting a part of or all of the ALPHA-1 system to another computer configuration or in another library environment. Author

N67-38584# Center for Naval Analyses, Washington, D. C. Operations Evaluation Group.
A REFERENCE-CONNECTING TECHNIQUE FOR AUTOMATIC INFORMATION CLASSIFICATION AND RETRIEVAL
M. J. Greene 10 Mar. 1967 22 p refs
(Contract N00014-67-C-0211)
(OEG-77; AD-654190)

A recent study of command information flow associated with the Dominican Republic coup of April-May 1965 introduced an analytical tool for identifying deficiencies in the flow and use of information which appears to have considerable potential as a general technique for information retrieval. Naval messages are associated with each other through their formal references in a manner analogous to the concept of joining as defined in a recent publication in directed graph theory by Harary, Norman, and Cartwright (Structural Models). Reference-connected sets are then constructed from message traffic dealing with the coup and are found to uniquely identify operational events during the crisis. Such sets (and subsets if further refinement is desired) can be obtained in real-time and a very simple method is demonstrated which automatically classifies messages as they enter the system. This technique, if applied to a library system, avoids both the problem of describing the subject covered in a document and the problem of integrating new subject matter into a predetermined classification code. It is user-oriented system which combines static coupling methods used in the Technical Information Project at MIT and converts them into a synamic process for both classification and retrieval. Thus, it concentrates on the evolution of the subject as represented by referenced documents upon which any new information is based and it has the additional advantage of reflecting the information flow among scientists in any field. Author (TAB)

N67-38640* Indiana Univ. Foundation, Bloomington. Aerospace Research Applications Center.
[EXPERIMENT IN TECHNOLOGY UTILIZATION, VOLUME I] Quarterly Report, May 1–Jul. 31, 1967
Joseph Di Salvo 30 Aug. 1967 118 p
(Contract NSR-15-003-055)
(NASA-CR-88275) CSCL 05B

The purpose of this organization is to formulate, design, and test information systems for linking industrial firms with the base of knowledge being developed through the programs of NASA and other government agencies. This volume contains a brief description of 15 projects currently being conducted at the Center and outlines progress in these projects. The bulk of the volume consists of a "key work in context" (KWIC) index which lists the 330 reports announced by the Center's Marketing Information Service during the period November 1964–July 1967 in its monthly publication "New Dimensions in Marketing Technology". The articles are designed to provide marketing managers with information on marketing management, research, and analysis, and they cover a wide spectrum of marketing subjects selected to reflect developments in marketing as well as in such related areas as operations research, communications, and sociology. K.W.

N67-38667*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
SPACE PROGRAMS SUMMARY NO. 37-27, VOLUME IV FOR THE PERIOD APRIL 1, 1964 TO MAY 31, 1964. SUPPORTING RESEARCH AND ADVANCED DEVELOPMENT
30 Jun. 1964 244 p refs
(Contract NAS7-100)
(NASA-CR-88106; JPL-SPS-37-27, Vol. IV) CFSTI: HC $3.00/MF $0.65 CSCL 22A

Space exploration programs, related supporting research, and advanced development projects are reported. Areas covered are systems analysis, spacecraft electrical power and guidance, materials, mechanics, technical facilities, solid propellant engineering, polymer research, liquid propulsion, space instruments, chemistry, fluid physics and communication systems. C.L.W.

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—NATIONAL AERONAUTICS AND SPACE ACT OF 1958

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